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**COMBINED TRANSMITTAL OF APPEAL BRIEF TO THE BOARD OF PATENT
APPEALS AND INTERFERENCES & PETITION FOR EXTENSION OF TIME
UNDER 37 C.F.R. 1.136(a) (Large Entity)**

AF-2814 \$
Docket No.
OKI.147

In Re Application Of: **K. Asakawa et al.**

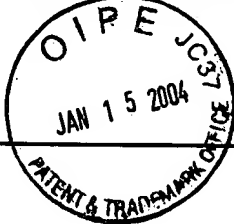
Serial No.
09/497,499

Filing Date
February 4, 2000

Examiner
W. Louie

Group Art Unit
2814

Invention: **SEMICONDUCTOR DEVICE AND METHOD OF FABRICATING SAME**



TO THE COMMISSIONER FOR PATENTS:

This is a combined Transmittal of Appeal Brief to the Board of Patent Appeals and Interferences and petition under the provisions of 37 CFR 1.136(a) to extend the period for filing an Appeal Brief.

Applicant(s) hereby request(s) an extension of time of (check desired time period):

☐ One month ☐ Two months ☒ Three months ☐ Four months ☐ Five months

from: October 12, 2003

Date

until: January 12, 2004

Date

The fee for the Appeal Brief and Extension of Time has been calculated as shown below:

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The fee for the Appeal Brief and extension of time is to be paid as follows:

- ☐ A check in the amount of _____ for the Appeal Brief and extension of time is enclosed.
- ☒ Please charge Deposit Account No. **50-0238** in the amount of **\$1,250.00**
- ☒ The Director is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. **50-0238**
- ☒ Any additional filing fees required under 37 C.F.R. 1.16.
- ☒ Any patent application processing fees under 37 CFR 1.17.
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**COMBINED TRANSMITTAL OF APPEAL BRIEF TO THE BOARD OF PATENT
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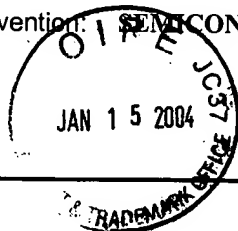
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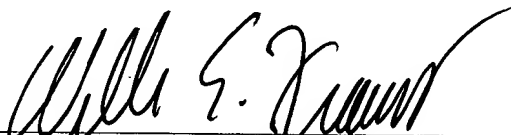
Group Art Unit
2814

Invention: **SEMICONDUCTOR DEVICE AND METHOD OF FABRICATING SAME**



TO THE COMMISSIONER FOR PATENTS:

This combined Transmittal of Appeal Brief to the Board of Patent Appeals and Interferences and petition for extension of time under 37 CFR 1.136(a) is respectfully submitted by the undersigned:


Signature

Dated: **January 12, 2004**

**William S. Francos (Reg. No. 38,456)
VOLENTINE FRANCOS, P.L.L.C.
12200 Sunrise Valley Drive
Suite 150
Reston, VA 20191
(703) 715-0870**

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Michelle Welgoss

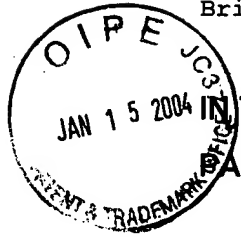
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Appl. No. 09/497,499

Brief on Appeal

Page 1 of 15



IN THE UNITED STATES

PATENT AND TRADEMARK OFFICE

Appl. No.: 09/497,499

Applicant(s): K. Asakawa, et al.

Filed: February 4, 2000

Title: SEMICONDUCTOR DEVICE AND METHOD
OF FABRICATING THE SAME

TC/A.U.: 2800/2814

Examiner: W. Louie

Atty. Docket: Oki.147

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On: 012 January 2004

By: *Michelle Welgoss*
Michelle Welgoss

BRIEF ON APPEAL BEFORE THE BOARD OF PATENT APPEALS AND
INTERFERENCES

Honorable Assistant Commissioner of Patents

P.O. Box 1450

Alexandria, VA 22313-1450

Sir:

In connection with the Notice of Appeal filed on August 12, 2003, Applicants
provide the following Brief on Appeal in triplicate in the above captioned application.

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1. Real Party in Interest

The real party in interest as assignee of the entire right and title to the invention described in the present application is Oki Electric Industry Co., Ltd. having an address at 7-12, Toranomom 1-chome, Minato-ku, Tokyo, Japan.

2. Related Appeals and Interferences

There are no known related appeals or interferences at this time.

3. Status of the Claims

Claims 10-22 are pending and have been finally rejected. Rejected claims 10-22 are duplicated in Appendix I.

4. Status of Amendments

A Final Office Action on the merits was mailed on February 12, 2003. In response thereto, the Notice of Appeal was filed.

5. Summary

According to an example embodiment a semiconductor memory device includes a first spin-on glass (SOG) layer 18a and a second SOG layer 18b, which serve as the interlayer dielectric of the memory device. These SOG layers are disposed over a substrate 10, and MOS structures are formed over and in the substrate 10. The SOG layer 18b is implanted to increase its density, which offers advantages described in the filed application. Finally, the SOG layer 18a is not implanted, and the SOG layer 18b is disposed over the SOG layer 18a. Further details are described in conjunction with example embodiments beginning on page 5 of the filed application.

6. Issues on Appeal

I. The issue on Appeal is whether claims 10-22 are properly rejected under 35 U.S.C. 103(a) as being unpatentable over *Watanabe, et al.* (U.S. Patent No. 5,808,363) in view of *Isobe, et al.* (U.S. Patent No. 5,716,872).

7. Grouping of Claims

Group I: Claims 10-12 stand or fall alone.

Group II: Claims 13-18 stand or fall alone.

Group III: Claims 19-22 stand or fall alone.

8. Argument

I. The first issue on appeal is the propriety of the rejection of claim 4 under 35 U.S.C. § 103(a) in view of over *Watanabe, et al.* (U.S. Patent No. 5,808,363) in view of *Isobe, et al.* (U.S. Patent No. 5,716,872). For at least the reasons that follow, this rejection is improper and should be withdrawn.

A proper rejection under 35 U.S.C. § 103(a) requires that **all** of the claimed elements be found in the applied art. If a **single** claimed element is not found in the applied art, a prima facie case of obviousness cannot be properly established.

Furthermore, obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is a teaching, suggestion or motivation to do so found in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine* 5 USPQ 2d 1596 (1988). However, hindsight is never an appropriate motivation for combining references and/or the requisite knowledge available to one having ordinary skill in the art. To this end, relying upon hindsight knowledge of applicants' disclosure when the prior art does not teach nor suggest such knowledge results in the use of the invention as a template for its own reconstruction. This is wholly

improper in the determination of patentability. *Sensonics Inc. v Aerosonics Corp.*, 38 USPQ 2d 1551-1554 (1996), citing *W.L. Gore & Associates, Inc. v. Garlock, Inc.* 220 USPQ 303.

Independent claims 10, 13, and 19 each include the limitation of:

"...a first SOG layer, which is formed in side surfaces of said dummy pattern and said first insulating layer; [and]

a second SOG layer, which is formed on a top surface of said dummy pattern and said first SOG layer, said second SOG layer being denser than said first SOG layer;..."

The Office Action of February 12, 2003 states that a first SOG layer 7 is taught by *Watanabe, et al.*; and that the reference to *Watanabe, et al.* further discloses an insulating layer 8 deposited on the SOG layer 7. Moreover, the Office Action states that "*Watanabe disclose an insulating layer 8 deposited on the SOG layer but does not disclose [that] the second layer formed on the top surface of the dummy pattern is SOG. However, Watanabe teaches [that] the insulating film may be of any insulative material, but is preferably made of SOG (col. 3, lines 1-2). Therefore it is obvious that the insulating layer 8 could be made of SOG.*" (Please refer to page 3 of the Office Action.)

It is agreed that the reference to *Watanabe et al.* does not specifically disclose that the fourth insulating layer 8 is SOG. In fact, the reference specifically teaches that the fourth *is a made of a plasma enhanced chemical vapor deposition (P-CVD) oxide layer, or plasma oxide layer*, which is not an SOG layer. To this end, P-CVD or PECVD silicon dioxide layers are formed by known plasma assisted deposition techniques, and result in the formation of a plasma oxide (SiO₂) layer. Contrastingly, and is also well-known to one of ordinary skill in the art of microelectronics design and fabrication that SOG is applied by spin-coating a slurry of material onto a wafer, and processing the slurry to realize an oxide material that can function as an insulating material.

SOG materials are not the same as plasma oxide (SiO_2) materials formed by P-CVD techniques. For example, SOG materials normally have a lower dielectric constant, on the order of approximately 3.1, whereas SiO_2 has a dielectric constant of 3.9. As such, it is clear that layer 8 of *Watanabe et al.* is not SOG, but rather a plasma oxide formed by a PECVD. (For further details of the fabrication of SOG in accordance with the example embodiments, kindly refer to page 6, lines 13-22 of the filed application. For differences in SOG and PECVD oxide materials, Applicants Attorney includes in Appendix IV a copy of an article "Optimization of Spin-On-Glass Process for Multilevel Metal Interconnects," Proceedings of the 14th University/Government/Industry Microelectronics Symposium, pp.136-139, Virginia Commonwealth University, Richmond, VA, June 17-20, 2001, by A. Maydayag, et al. This article was uncovered by the undersigned attorney during the preparation of the present Brief on Appeal.)

It appears that the Office Action relies on the disclosure in the Summary of the Invention of *Watanabe et al.* for the disclosure that the second insulating layer 8 is an SOG layer (i.e., the reference in the Office Action to column 3, lines 1-2 of *Watanabe et al.*). This is incorrect for at least the following reasons. First, as noted above, the layer 8 in *Watanabe et al.* is a P-CVD-formed plasma oxide layer, which is not the same as an SOG layer. Second, in the Summary of the Invention, the reference to *Watanabe et al.* discloses that an **insulating film** formed on the **interlayer insulating film** may be made of any insulative material, but is preferably organic silica (SOG). However, in this portion of the disclosure of *Watanabe et al.*, **the insulating film** is described only as a **single layer; and is the only layer** that is disclosed as being SOG. There are other layers described in this portion of the Summary, but these are referred to as **interlayer insulating films**. These are not described as being SOG films. To wit, the reference does not teach nor suggest that the interlayer insulating film is SOG. Accordingly, because the Description of the Preferred Embodiments of *Watanabe, et al.* only describes one layer (SOG layer 7)

as being an SOG layer, this must be the layer so-referenced in the Summary of *Watanabe, et al.* (Please refer to the Abstract of *Watanabe et al.*, as well as column 2, line 3, lines 1-2 for support for the above assertions.)

Finally, it is respectfully submitted that it is not reasonable to assert that layer 8 is SOG when the disclosure specifically recited that it is P-CVD-formed plasma oxide. Accordingly, and for at least the reasons set forth above, the teaching of *Watanabe, et al.* cannot meet the claimed limitation of a first SOG layer with a second SOG layer thereon having the other characteristics of Applicants' independent claims cited above.

In furtherance of their position, Applicants noted that in the Description of the Preferred Embodiments, *Watanabe et al.* teaches a first embodiment having a **first insulating film 2** of silicon dioxide layer that is formed over a semiconductor substrate 1 by **chemical vapor deposition (CVD)**. **A second insulating film 4** is formed over the fuses and the first insulating film 2. **A third insulating film 6, which is a plasma oxide**, is formed over the tungsten wiring layer 5 and the second insulating film 4 by plasma CVD. Next the **organic silica film (SOG) 7** is formed over the third insulating film 6. Thereafter the **fourth insulating layer 8 of plasma oxide** is formed over the SOG film 7. A wiring layer 9 of AlSiCu and TiN are formed over the fourth insulating layer 8; and a cover layer 10 is formed over the wiring layer 9. (Please refer to column 4, line 22, to column 5, line 7 of *Watanabe et al.* for further details.)

From the disclosure of the first embodiment of *Watanabe, et al.* it is clear that **only one layer of the insulating layers (organic layer 7) is specifically disclosed as being SOG**. While the reference is silent on the specific material used for the second insulating film, even if it were the case that this layer were SOG (a proposition that Applicants that is made for the sake of argument; and one that Applicants in no way concede), the reference to *Watanabe et al.* would be void

nonetheless of the teaching of the **second SOG layer formed on a first SOG layer** having the characteristics specifically set forth in independent claims 10, 13, and 19. Moreover, the reference specifically recites that the **fourth insulating film 8 is a plasma oxide film** (i.e. SiO₂), and therefore, it does not teach that this film is a SOG layer. (It is noted that a second embodiment is disclosed by *Watanabe et al.*, but differs from the first only in the disclosure of two dummy wiring layers.)

In summary, *Watanabe et al.* discloses the **use of only one organic layer (SOG)** in any given embodiment. Accordingly, for at least this reason, the reference to *Watanabe et al.* lacks the teaching of the **two SOG layers**, featured in and having the characteristics recited in independent claims 10, 13, and 19. Thus, the reference to *Watanabe et al.* lacks at least a teaching of at least one of the claimed elements of independent claims 10, 13 and 19. As such, and without conceding to the propriety of the combination of *Watanabe et al.* and *Isobe et al.*, or to the asserted teachings of *Isobe, et al.*, because the applied art fails to disclose **at least one of the features** of claims 10, 13 and 19, a *prima facie* case of obvious has not been properly established. Therefore, it is respectfully submitted that independent claims 10, 13, and 19, and the claims that depend directly or indirectly therefrom are believed to be allowable over the applied art.

Conclusion

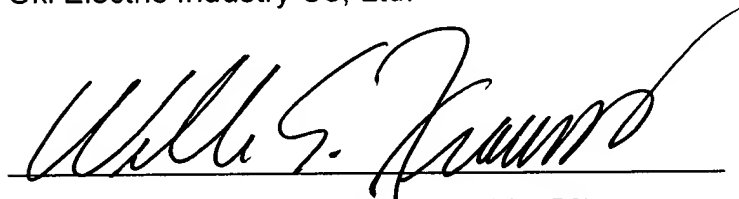
In view of the foregoing, applicant(s) respectfully request(s): the withdrawal of all objections and rejections of record; the allowance of all the pending claims; and the holding of the application in condition for allowance. If any points remain in issue that may best be resolved through a personal or telephonic interview, the Examiner is respectfully requested to contact the undersigned at the telephone number listed below.

If necessary, the Commissioner is hereby authorized in this, concurrent, and further replies to charge payment or credit any overpayment to Deposit Account Number 50-0238 for any additional fees under 37 C.F.R. §1.16 or under 37 C.F.R. §1.17.

In the event that there are any outstanding matters remaining in the present application, the Examiner is invited to contact William S. Francos, Esq. (Reg. No. 38,456) at (610) 375-3513 to discuss these matters.

Respectfully submitted on behalf of:

Oki Electric Industry Co, Ltd.

A handwritten signature in black ink, appearing to read 'William S. Francos', is written over a horizontal line.

by: William S. Francos (Reg. No. 38,456)

January 12, 2004

Volentine Francos, PLLC
1220 Sunrise Valley Dr.
Suite 150
Reston, VA 20191
(610) 375-3513 (Mr. Francos'
telephone number in the PA office
of the firm.)

APPENDIX I
Claims on Appeal

Claims on Appeal:

10. A semiconductor device comprising:

a semiconductor substrate which has first and second regions formed on a major surface thereof;

a first insulating layer which is formed over the first region;

a dummy pattern which has a predetermined shape and which is formed on said first insulating layer;

a first SOG layer which is formed on side surfaces of said dummy pattern and the first insulating layer;

a second SOG layer which is formed on a top surface of said dummy pattern and said first SOG layer, said second SOG layer being denser than said first SOG layer; and

a second insulating layer which is formed on said second SOG layer;

wherein said first and second insulating layers and said first and second SOG layers are exposed at a boundary between the first region and the second region.

11. A semiconductor device as set forth in claim 10, wherein the second region is a grid line.

12. A semiconductor device as set forth in claim 10, further comprising a fuse element which is formed over the second region.

13. A semiconductor device comprising:

a semiconductor substrate which has first and second regions formed on a major surface thereof, the second region surrounding the first region;

a first insulating layer which is formed over the second region;

a dummy pattern which has a frame shape surrounding the first region and which is formed on said first insulating layer;

a first SOG layer which is formed on side surfaces of said dummy pattern and the first insulating layer;

a second SOG layer which is formed on a top surface of said dummy pattern and said first SOG layer; said second SOG layer being denser than said first SOG layer; and

a second insulating layer which is formed on said second SOG layer;

wherein said first and second insulating layers and said first and second SOG layers are exposed at a boundary between the first region and the second region.

14. A semiconductor device as set forth in claim 13, further comprising a fuse element which is formed over the first region.

15. A semiconductor device as recited in claim 10, wherein said second SOG layer further includes ions chosen from the group consisting essentially of:
argon; fluorine; nitrogen; IIIb-element; IVb-element; Vb-element; VIb-element; VIIb-element; IVa-element; and Va-element.

16. A semiconductor device as recited in claim 13, wherein said second SOG layer further includes ions chosen from the group consisting essentially of:
argon; fluorine; nitrogen; III b-element; IV b-element; V b-element; VI b-element; VII b-element; IV a-element; and V a-element.

17. A semiconductor device as recited in claim 12, wherein said fuse element is a laser blown fuse element.

18. A semiconductor device as recited in claim 14, wherein said fuse element is a laser blown fuse element.

19. (Newly Added) A semiconductor memory device, comprising:

a semiconductor substrate, which has a first region and a second region formed on a major surface thereof;

a first insulating layer, which is formed over the first region;

a dummy pattern, which has a predetermined shape, and which is formed on said first insulating layer;

a first SOG layer, which is formed in side surfaces of said dummy pattern and said first insulating layer;

a second SOG layer, which is formed on a top surface of said dummy pattern and said first SOG layer, said second SOG layer being denser than said first SOG layer; and

a second insulating layer, which is formed on said second SOG layer, wherein said first and second insulating layers and said first and second SOG layers are exposed at a boundary between the first region and the second region.

20. (Newly Added) A semiconductor memory device as recited in claim 20, wherein the memory device is a DRAM.

21. (Newly Added) A semiconductor memory device as recited in claim 20, further comprising a redundant circuit having a redundant memory cell.

22. (Newly Added) A semiconductor memory device as recited in claim 20, further comprising a plurality of laser blown fuses.

APPENDIX II
Applied References

APPENDIX III
Cited Court Decisions

FULL TEXT OF CASES (USPQ2D)

All Other Cases

In re Fine (CA FC) 5 USPQ2d 1596 (1/26/1988)

In re Fine (CA FC) 5 USPQ2d 1596

In re Fine**U.S. Court of Appeals Federal Circuit**
5 USPQ2d 1596

Decided January 26, 1988

No. 87-1319

Headnotes**PATENTS****1. Patentability/Validity -- Obviousness -- Evidence of (§ 115.0903)**

Patent and Trademark Office improperly rejected claimed invention for obviousness since nothing in cited references, either alone or in combination, suggests or teaches claimed invention, since there is consequently no support for PTO's conclusion that substitution of one type of detector for another in prior art system, resulting in claimed invention, would have been obvious, and since PTO therefore failed to satisfy its burden of establishing prima facie case of obviousness by showing some objective teaching or generally available knowledge that would lead one skilled in art to combine teachings of existing references.

2. Patentability/Validity -- Obviousness -- In general (§ 115.0901)

Obviousness is tested by what combined teachings of prior art references would have suggested to those of ordinary skill in art, not by whether particular combination of elements from such references might have been "obvious to try."

3. Patentability/Validity -- Obviousness -- Evidence of (§ 115.0903)

Patent and Trademark Office erred, in rejecting as obvious system for detecting and measuring minute quantities of nitrogen compounds, by failing to recognize that appealed claims can be distinguished over combination of prior art references, in view of evidence demonstrating that prior art does not teach

claimed temperature range, despite some overlap of preferred temperature ranges for claimed invention and prior art, since purposes of preferred temperature ranges are different and overlap is mere happenstance.

4. Patentability/Validity -- Obviousness -- In general (§ 115.0901)

Dependent claims are non-obvious under 35 USC 103 if claims from which they depend are non-obvious.

Case History and Disposition:

Page 1597

Appeal from the U.S. Patent and Trademark Office Board of Patent Appeals and Interferences.

Application for patent by David H. Fine, Serial No. 512,374. From decision of Board of Patent Appeals and Interferences affirming rejection of application, applicant appeals. Reversed; Smith, circuit judge, dissenting with opinion.

Attorneys:

Morris Relson and Darby & Darby, New York, N.Y., (Beverly B. Goodwin with them on the brief) for appellant.

Lee E. Barrett, associate solicitor, Arlington, Va., (Joseph F. Nakamura, solicitor, and Fred E. McKelvey, deputy solicitor, with him on the brief) for appellee.

Judge:

Before Friedman, Smith, and Mayer, circuit judges.

Opinion Text

Opinion By:

Mayer, J.

David H. Fine appeals from a decision of the Board of Patent Appeals and Interferences of the United States Patent and Trademark Office (Board) affirming the rejection of certain claims of his application, Serial No. 512,374, and concluding that his invention would have been obvious to one of ordinary skill in the art and was therefore unpatentable under 35 U.S.C. §103. We reverse.

Background

A. The Invention .

The invention claimed is a system for detecting and measuring minute quantities of nitrogen compounds. According to Fine, the system has the ability to detect the presence of nitrogen compounds in quantities as minute as one part in one billion, and is an effective means to detect drugs and explosives, which emanate nitrogen compound vapors even when they are concealed in luggage and

closed containers.

The claimed invention has three major components: (1) a gas chromatograph which separates a gaseous sample into its constituent parts; (2) a converter which converts the nitrogen compound effluent output of the chromatograph into nitric oxide in a hot, oxygen-rich environment; and (3) a detector for measuring the level of nitric oxide. The claimed invention's sensitivity is achieved by combining nitric oxide with ozone to produce nitrogen dioxide which concurrently causes a detectable luminescence. The luminescence, which is measured by a visual detector, shows the level of nitric oxide which in turn is a measure of nitrogen compounds found in the sample.

The appealed claims were rejected by the Patent and Trademark Office (PTO) under 35 U.S.C. §103. Claims 60, 63, 77 and 80 were rejected as unpatentable over Eads, Patent No. 3,650,696 (Eads) in view of Warnick, et al., Patent No. 3,746,513 (Warnick). Claims 62, 68, 69, 79, 85 and 86 were rejected as unpatentable over Eads and Warnick in view of Glass, et al., Patent No. 3,207,585 (Glass).

B. The Prior Art .

1. Eads Patent .

Eads discloses a method for separating, identifying and quantitatively monitoring sulfur compounds. The Eads system is used primarily in "air pollution control work in the scientific characterization of odors from sulfur compounds."

The problem addressed by Eads is the tendency of sulfur compounds "to adhere to or react with the surface materials of the sampling and analytical equipment, and/or react with the liquid or gaseous materials in the equipment." Because of this, the accuracy

Page 1598

of measurement is impaired. To solve the problem, the Eads system collects an air sample containing sulfur compounds in a sulfur-free methanol solution. The liquid is inserted into a gas chromatograph which separates the various sulfur compounds. The compounds are next sent through a pyrolysis furnace where they are oxidized to form sulfur dioxide. Finally, the sulfur dioxide passes through a measuring device called a microcoulometer which uses titration cells to calculate the concentration of sulfur compounds in the sample.

2. Warnick Patent .

Warnick is directed to a means for detecting the quantity of pollutants in the atmosphere. By measuring the chemiluminescence of the reaction between nitric oxide and ozone, the Warnick device can detect the concentration of nitric oxide in a sample gaseous mixture.

Warnick calls for "continuously flowing" a sample gaseous mixture and a reactant containing ozone into a reaction chamber. The chemiluminescence from the resulting reaction is transmitted through a light-transmitting element to produce continuous readouts of the total amount of nitric oxide present in the sample.

3. Glass Patent.

The invention disclosed in Glass is a device for "completely burning a measured amount of a substance and analyzing the combustion products." A fixed amount of a liquid petroleum sample and oxygen are supplied to a flame. The flame is then spark-ignited, causing the sample to burn. The resulting combustion products are then collected and measured, and from this measurement the hydrogen concentration in the sample is computed.

C. The Rejection .

The Examiner rejected claims 60, 63, 77 and 80 because "substitution of the [nitric oxide] detector of Warnick for the sulfur detector of Eads would be an obvious consideration if interested in nitrogen compounds, and would yield the claimed invention." He further asserted that "Eads teaches the

[claimed] combination of chromatograph, combustion, and detection, in that order. . . . Substitution of detectors to measure any component of interest is well within the skill of the art." In rejecting claims 62, 68, 69, 79, 85 and 86, the Examiner said, "Glass et al. teach a flame conversion means followed by a detector, and substitution of the flame conversion means of Glass et al. for the furnace of Eads would be an obvious equivalent and would yield the claimed invention." The Board affirmed the Examiner's rejection.

Discussion

A. Standard of Review .

Obviousness under 35 U.S.C. §103 is " 'a legal conclusion based on factual evidence.' " *Stratoflex, Inc. v. Aeroquip Corp.* , 713 F.2d 1530, 1535, 218 USPQ 871, 876 (Fed. Cir. 1983) (quoting *Stevenson v. Int'l Trade Comm'n* , 612 F.2d 546, 549, 204 USPQ 276, 279 (CCPA 1979)). Therefore, an obviousness determination is not reviewed under the clearly erroneous standard applicable to fact findings, *Raytheon Co. v. Roper Corp.* , 724 F.2d 951, 956, 220 USPQ 592, 596 (Fed. Cir. 1983); it is "reviewed for correctness or error as a matter of law." *In re De Blauwe* , 736 F.2d 699, 703, 222 USPQ 191, 195 (Fed. Cir. 1984).

To reach a proper conclusion under §103, the decisionmaker must step backward in time and into the shoes worn by [a person having ordinary skill in the art] when the invention was unknown and just before it was made. In light of *all* the evidence, the decisionmaker must then determine whether . . . the claimed invention as a whole would have been obvious at *that* time to *that* person. 35 U.S.C. §103. The answer to that question partakes more of the nature of law than of fact, for it is an ultimate conclusion based on a foundation formed of all the probative facts.

Panduit Corp. v. Dennison Mfg. Co. , 810 F.2d 1561, 1566, 1 USPQ2d 1593, 1595-96 (Fed. Cir. 1987).

B. Prima Facie Obviousness .

Fine says the PTO has not established a *prima facie* case of obviousness. He contends the references applied by the Board and Examiner were improperly combined, using hindsight reconstruction, without evidence to support the combination and in the face of contrary teachings in the prior art. He argues that the appealed claims were rejected because the PTO thought it would have been "obvious to try" the claimed invention, an unacceptable basis for rejection.

[1] We agree. The PTO has the burden under section 103 to establish a *prima facie* case of obviousness. See *In re Piasecki* , 745 F.2d 1468, 1471-72, 223 USPQ 785, 787-87 (Fed. Cir. 1984). It can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. *In re Lahu* , 747 F.2d 703, 705, 223 USPQ 1257, 1258 (Fed. Cir. 1984); see also *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.* ,

Page 1599

776 F.2d 281, 297 n.24, 227 USPQ 657, 667 n.24 (Fed. Cir. 1985); *ACS Hosp. Sys., Inc. v. Montefiore Hosp.* , 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984). This it has not done. The Board points to nothing in the cited references, either alone or in combination, suggesting or teaching Fine's invention.

The primary basis for the Board's affirmance of the Examiner's rejection was that it would have been obvious to substitute the Warnick nitric oxide detector for the Eads sulfur dioxide detector in the Eads system. The Board reiterated the Examiner's bald assertion that "substitution of one type of detector for another in the system of Eads would have been within the skill of the art," but neither of them offered any support for or explanation of this conclusion.

Eads is limited to the analysis of sulfur compounds. The particular problem addressed there is the difficulty of obtaining precise measurements of sulfur compounds because of the tendency of sulfur dioxide to adhere to or react with the sampling analytic equipment or the liquid or gaseous materials in

the equipment. It solves this problem by suggesting that the gaseous sample containing sulfur compounds be absorbed into sulfur-free methanol and then inserted into a gas chromatograph to separate the sulfur compounds.

There is no suggestion in Eads, which focuses on the unique difficulties inherent in the measurement of sulfur, to use that arrangement to detect nitrogen compounds. In fact, Eads says that the presence of nitrogen is undesirable because the concentration of the titration cell components in the sulfur detector is adversely affected by substantial amounts of nitrogen compounds in the sample. So, instead of suggesting that the system be used to detect nitrogen compounds, Eads deliberately seeks to avoid them; it warns against rather than teaches Fine's invention. See *W. L. Gore & Assoc. v. Garlock, Inc.*, 721 F.2d 1540, 1550, 220 USPQ 303, 311 (Fed. Cir. 1983) (error to find obviousness where references "diverge from and teach away from the invention at hand"). In the face of this, one skilled in the art would not be expected to combine a nitrogen-related detector with the Eads system. Accordingly, there is no suggestion to combine Eads and Warnick.

Likewise, the teachings of Warnick are inconsistent with the claimed invention, to some extent. The Warnick claims are directed to a gas stream from engine exhaust "continuously flowing the gaseous mixtures into the reaction chamber" to obtain "continuous readouts" of the amount of nitric oxide in the sample. The other words, it contemplates measuring the total amount of nitric oxide in a continuously flowing gaseous mixture of unseparated nitrogen constituents. By contrast, in Fine each nitrogen compound constituent of the gaseous sample is retained in the Chromatograph for an individual time period so that each exists in discrete, time-separated pulses. *By this process, each constituent may be both identified by its position in time sequence, and measured. The claimed system, therefore, diverges from Warnick and teaches advantages not appreciated or contemplated by it.

Because neither Warnick nor Eads, alone or in combination, suggests the claimed invention, the Board erred in affirming the Examiner's conclusion that it would have been obvious to substitute the Warnick nitric oxide detector for the Eads sulfur dioxide detector in the Eads system. *ACS Hosp. Sys.*, 732 F.2d at 1575-77, 221 USPQ at 931-33. The Eads and Warnick references disclose, at most, that one skilled in the art might find it obvious to try the claimed invention. But whether a particular combination might be "obvious to try" is not a legitimate test of patentability. *In re Geiger*, 815 F.2d 868, 688, 2 USPQ2d 1276, 1278 (Fed. Cir. 1987); *In re Goodwin*, 576 F.2d 375, 377, 198 USPQ 1, 3 (CCPA 1978).

[2] Obviousness is tested by "what the combined teachings of the references would have suggested to those of ordinary skill in the art." *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 881 (CCPA 1981). But it "cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination." *ACS Hosp. Sys.*, 732 F.2d at 1577, 221 USPQ at 933. And "teachings of references can be combined *only* if there is some suggestion or incentive to do so." *Id.* Here, the prior art contains none.

Instead, the Examiner relies on hindsight in reaching his obviousness determination.

Page 1600

But this court has said, "To imbue one of ordinary skill in the art with knowledge of the invention in suit, when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher." *W. L. Gore*, 721 F.2d at 1553, 220 USPQ at 312-13. It is essential that "the decisionmaker forget what he or she has been taught at trial about the claimed invention and cast the mind back to the time the invention was made . . . to occupy the mind of one skilled in the art who is presented only with the references, and who is normally guided by the then-accepted wisdom in the art." *Id.* One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.

C. Advantage Not Appreciated by the Prior Art .

[3] The Board erred not only in improperly combining the Eads and Warnick references but also in

failing to appreciate that the appealed claims can be distinguished over that combination. A material limitation of the claimed system is that the conversion to nitric oxide occur in the range of 600°C to 1700°C. The purpose of this limitation is to prevent nitrogen from other sources, such as the air, from being converted to nitric oxide and thereby distorting the measurement of nitric oxide derived from the nitrogen compounds of the sample.

The claimed nitric oxide conversion temperature is not disclosed in Warnick. Although Eads describes a preferred temperature of 675°C to 725°C, the purpose of this range is different from that of Fine. Eads requires the 675°C to 725°C range because it affords a temperature low enough to avoid formation of unwanted sulfur trioxide, yet high enough to avoid formation of unwanted sulfides. Fine's temperature range, in contrast, does not seek to avoid the formation of sulfur compounds or even nitrogen compounds. It enables the system to break down the nitrogen compounds of the sample while avoiding the destruction of background nitrogen gas. There is a partial overlap, of course, but this is mere happenstance. Because the purposes of the two temperature ranges are entirely unrelated, Eads does not teach use of the claimed range. See *In re Geiger*, 815 F.2d at 688, 2 USPQ2d at 1278. The Board erred by concluding otherwise.

D. Unexpected Results .

Because we reverse for failure to establish a *prima facie* case of obviousness, we need not reach Fine's contention that the Board failed to accord proper weight to the objective evidence of unexpected superior results. *Id.*

E. The "Flame" Claims .

[4] Claims 62, 68, 69, 79, 85 and 86 relate to the oxygen-rich flame conversion means of the claimed invention. These "flame" claims depend from either apparatus claim 60 or method claim 77. Dependent claims are nonobvious under section 103 if the independent claims from which they depend are nonobvious. *Hartness Int'l, Inc. v. Simplimatic Eng'g Co.*, 819 F.2d 1100, 1108, 2 USPQ2d 1826, 1831 (Fed. Cir. 1987); *In re Abele*, 684 F.2d 902, 910, 214 USPQ 682, 689 (CCPA 1982); see also *In re Sernaker*, 702 F.2d 989, 991, 217 USPQ 1, 3 (Fed. Cir. 1983). In view of our conclusion that claims 60 and 77 are nonobvious, the dependent "flame" claims are also patentable.

Conclusion

The Board's decision affirming the Examiner's rejection of claims 60, 62, 63, 68, 69, 77, 79, 80, 85 and 86 of Fine's application as unpatentable over the prior art under 35 U.S.C. §103 is **REVERSED**.

Footnotes

Footnote *. The Solicitor argues that the contents of Attachment C of Fine's brief were not before the Board and may not properly be considered here. However, we need not rely on Attachment C. It is merely illustrative of the qualitative separation of nitrogen compounds which occurs in Fine's system. The fact that the various constituents exit at discrete intervals is shown by the specification which was before the Board and which may appropriately be considered on appeal. See, e.g., *Astra-Sjuco, A.B. v. United States Int'l Trade Comm'n*, 629 F.2d 682, 686, 207 USPQ 1, 5 (CCPA 1980) (claims must be construed in light of specification).

Dissenting Opinion Text

Dissent By:

Smith, circuit judge, dissenting.

I respectfully dissent. I am of the firm belief that the prior art references, relied upon by the PTO to establish its *prima facie* case of obviousness, in combination teach and suggest Fine's invention to one

skilled in the art. Also, I firmly believe that Fine failed to rebut the PTO's prima facie case. On this basis, I would affirm the board's determination sustaining the examiner's rejection, pursuant to 35 U.S.C. §103, of Fine's claims on appeal before this court.

- End of Case -

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US005808363A

United States Patent [19]

Watanabe

[11] Patent Number: **5,808,363**[45] Date of Patent: **Sep. 15, 1998****[54] SEMICONDUCTOR DEVICE AND METHOD OF FABRICATING THE SAME**

[75] Inventor: Takeshi Watanabe, Tokyo, Japan

[73] Assignee: NEC Corporation, Tokyo, Japan

[21] Appl. No.: 748,838

[22] Filed: Nov. 14, 1996

[30] Foreign Application Priority Data

Nov. 15, 1995 [JP] Japan 7-296551

[51] Int. Cl.⁶ H01L 23/48

[52] U.S. Cl. 257/758; 257/773

[58] Field of Search 27/758-760, 750,
27/752, 773, 529, 665**[56] References Cited****U.S. PATENT DOCUMENTS**

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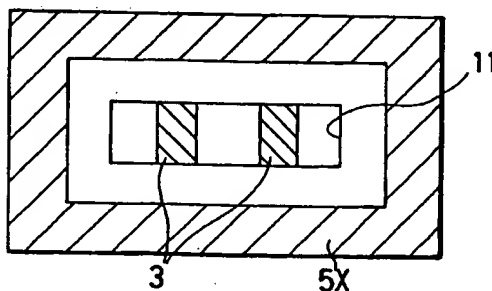
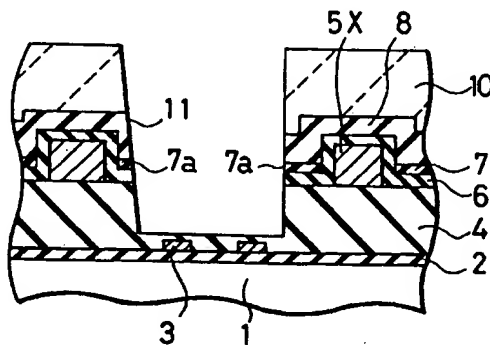
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Primary Examiner—Sara W. Crane

Attorney, Agent, or Firm—Sughrue, Mion, Zinn, Macpeak & Seas, PLLC

[57] ABSTRACT

There is provided a semiconductor device including an upper wiring layer, a lower wiring layer, an interlayer insulating film sandwiched between the upper and lower wiring layers for electrically insulating the upper and lower wiring layers to each other, an insulating film formed on the interlayer insulating film, the insulating film being in planarized condition, and a wiring layer formed on a level with the insulating layer. The wiring layer horizontally surrounds a pit formed through the upper and lower wiring layers, the interlayer insulating film and the insulating film. Cut ends of the insulating film are exposed to a sidewall of the pit. Even if humidity is absorbed into the insulating film through the cut ends thereof exposed to the pit, humidity is not allowed to reach an internal circuit, because the insulating film is divided by the wiring layer. Thus, it is possible to prevent deterioration of performance and reliability of a semiconductor device which would be caused by humidity.

20 Claims, 7 Drawing Sheets



US005716872A

United States Patent [19]

Isobe

[11] Patent Number: 5,716,872

[45] Date of Patent: Feb. 10, 1998

[54] METHOD OF MANUFACTURING
MULTILAYER INTERCONNECTION
STRUCTURE HAVING A DIELECTRIC FILM
WITH IMPROVED FLATNESS

[75] Inventor: Akira Isobe, Tokyo, Japan

[73] Assignee: NEC Corporation, Tokyo, Japan

[21] Appl. No.: 563,201

[22] Filed: Nov. 27, 1995

[30] Foreign Application Priority Data

Nov. 29, 1994 [JP] Japan 6-294866

[51] Int. Cl.⁶ H01L 21/469

[52] U.S. Cl. 437/195; 437/228; 437/231

[58] Field of Search 437/195, 231,
437/245, 228 ION, 228 PL, 228 POL

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Primary Examiner—John Niebling

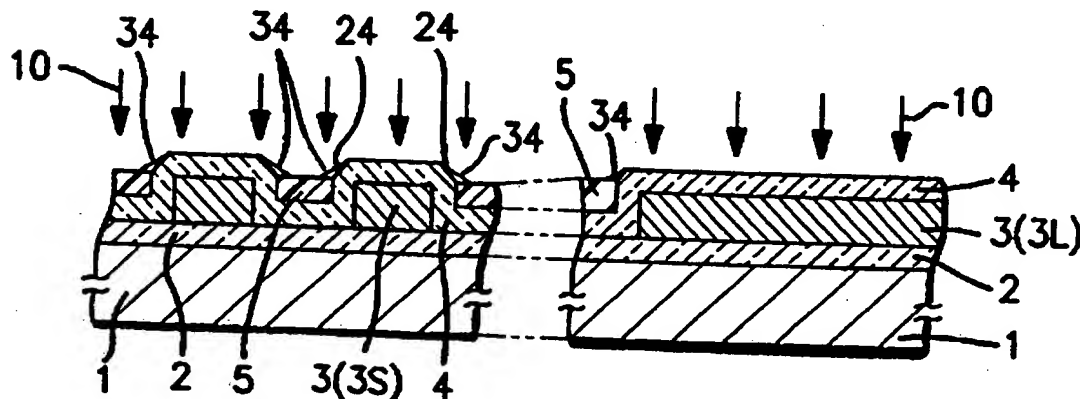
Assistant Examiner—C. Everhart

Attorney, Agent, or Firm—Young & Thompson

[57] ABSTRACT

A wiring pattern is formed on an insulating film provided on one major surface of a semiconductor substrate. Then, a first dielectric film covering the wiring pattern is formed. A second dielectric film is formed on the first dielectric film by coating and baking. Then, the second dielectric film is etched until at least a part of the first dielectric film on steps of the wiring pattern is exposed. The steps between the first dielectric film and the second dielectric film are smoothed by the irradiation of the entire surface with low energy ions. Then, a third dielectric film is formed covering the first and second dielectric films.

7 Claims, 4 Drawing Sheets



June 22, 1983. These two papers, filed before decision, deal only with the printing of the Combined Appendix of ten volumes said to contain a total of 9,307 pages, 5,743 of which were designated by appellee after appellants had initially designated the balance. There is an excessively detailed dispute over how many of the pages designated by appellee were necessary. Appellee appears not to have contributed to the cost of printing the appendix, which cost, paid by appellants, is said to have been \$31,850.15. Federal Rule of Appellate Procedure (FRAP) 30(b) authorizes us to impose upon a party the cost of printing material "unnecessarily" included. FRAP Rule 39(a) provides that, in the absence of an order by the court, in the case of a reversal "costs shall be taxed against the appellee."

Having considered the foregoing, we have a clear appreciation of the impossibility of determining, within reason, exactly what was or was not necessarily included in the appendix in this extended and complex litigation. We conclude that, under all of the circumstances with which we have necessarily become familiar in deciding this case, it is fair and equitable that the parties share equally the cost of printing the Combined Appendix and that otherwise each party bear its own costs. In accordance with Rule 39(a), it is so ordered.

Reversed and Remanded.

Miller, Circuit Judge, concurring in part.

Although I agree with the majority's analysis and holding on the fraud issue, it seems appropriate to state my conclusion that, because of the unpredictability of propanil in 1957, the district court erred in granting R&H an April 4, 1957, date of conception rather than a date concurrent with a reduction to practice, in the summer of 1957 — after the May 27, 1957, date of filing of Monsanto's application, so that the Monsanto patent constitutes a 35 U.S.C. §102(c) bar to the R&H patent. *Alpert v. Slatin*, 305 F.2d 891, 896, 134 USPQ 296, 301 (CCPA 1962).

Court of Appeals, Federal Circuit

W.L. Gore & Associates, Inc.
v. Garlock, Inc.

Nos. 83-613/614

Decided Nov. 14, 1983

PATENTS

1. Court of Appeals for the Federal Circuit — Weight given decision reviewed (§26.59)

Parties' argument relating to salutary injunction of FRCivP 52(a) cannot be controlling on all issues, where dispositive legal error occurred in interpretation and application of patent statute, 35 USC.

2. Court of Appeals for the Federal Circuit — Weight given decision reviewed (§26.59)

Findings that rest on erroneous view of law may be set aside on that basis.

3. Construction of specification and claims — Claim defines invention (§22.30)

Claims measure and define invention.

4. Construction of specification and claims — Combination claims (§22.35)

Infringement — Process patents (§39.65)

Court's restriction of claimed multi-step process to one step constitutes error, whether done at behest of patentee relying on that restriction to establish infringement by one who employs only that one step in process otherwise distinct, or at behest of accused infringer relying on that restriction to establish invalidity by showing that one step in prior art process otherwise distinct; invention must be considered as whole.

5. Court of Appeals for the Federal Circuit — Weight given decision reviewed (§26.59)

CAFC is not at liberty to substitute its own for district court's findings underlying district court's conclusion that claim is invalid.

6. Patentability — Anticipation — Process (§51.225)

It is irrelevant that those using invention may not have appreciated results where patent owner's operation of device is consistent, reproducible use of claimed invention; were that alone enough to prevent anticipation, it would be possible to obtain patent for old and unchanged process.

7. Use and sale — Extent and character of use (§69.5)

Nonsecret use of claimed process in usual course of producing articles for commercial purposes is public use.

8. Use and sale — Extent and character of use (§69.5)

Patentees' commercialization of product produced by its patented process can result in forfeiture of patent granted them for that process on application filed by them more than one year later; however, their secret commercialization of process cannot be bar to patent grant on that process.

9. Patent grant — Intent of patent laws (§50.15)

Early public disclosure is linchpin of patent system.

10. Interference — Priority (§41.70)

Law disfavors prior inventor who benefits from process by selling its product but suppresses, conceals, or otherwise keeps process from public, as against later inventor who promptly files patent application from which public will gain disclosure of process.

11. Patentability — Evidence of — In general (§51.451)

District court that in its consideration of prior art disregarded unpredictability and unique nature of product to which claimed inventions relate errs.

12. Construction of specification and claims — By prior art (§22.20)

District court that in its consideration of prior art considers claims in less than their entireties errs.

13. Patentability — Evidence of — Suggestions of prior art (§51.469)

District court that considers references in less than their entireties, i.e., in disregarding disclosures in references that diverge from and teach away from invention at hand, errs.

14. Construction of specification and claims — Comparison with other claims (§22.40)

Claims must be considered individually and separately.

15. Patentability — Anticipation — Combining references (§51.205)

There must have been something present in teachings in references to suggest to one skilled in art that claimed invention before court would have been obvious.

16. Patentability — Evidence of — Suggestions of prior art (§51.469)

Fact that patentee proceeded contrary to accepted wisdom of prior art is strong evidence of nonobviousness.

17. Patentability — Tests of — Skill of art (§51.707)

Imbuing one of ordinary skill in art with knowledge of invention in suit, when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to insidious effect of hindsight syndrome wherein that which only inventor taught is used against its teacher.

18. Patentability — Invention — In general (§51.501)

Patentability — Tests of — Skill of art (§51.707)

Decisionmaker must forget what he or she has been taught at trial about claimed invention and cast mind back to time invention was made to occupy mind of one skilled in art who is presented only with references, and who is normally guided by then-accepted wisdom in art.

19. Pleading and practice in courts — Burden of proof — Validity (§53.138)

Presumption for patent grant — Patent Office consideration of prior art (§55.5)

It is not law that presumption of validity is weakened greatly where Patent Office has failed to consider pertinent prior art; presumption has no separate evidentiary value; it cautions decisionmaker against rush to conclude invalidity; submission of additional art that is merely "pertinent" does not dispel that caution; however, inescapable burden of persuasion on one who would prove invalidity remains throughout trial.

20. Pleading and practice in courts — Burden of proof — Validity (§53.138)

Presumption from patent grant — Patent Office consideration of prior art (§55.5)

Burden of proving invalidity may be facilitated by prior art that is more pertinent than that considered by PTO.

21. Patentability — Evidence of — In general (§51.451)

District court that specifically declines to consider objective evidence of nonobviousness errs; that evidence can often serve as-insur-

ance against insidious attraction of siren hindsight when confronted with difficult task of evaluating prior art; even when prior art evidence points more in direction of nonobviousness than obviousness, objective evidence may tend to reassure decisionmaker.

22. Patentability — Anticipation — In general (§51.201)

Anticipation requires disclosure in single prior art reference of each element of claim under consideration.

23. Patentability — Anticipation — Process (§51.225)

Patentability — Composition of matter (§51.30)

Anticipation of inventions set forth in product claims cannot be predicated on mere conjecture respecting characteristics of products that might result from practice of processes disclosed in references.

24. Patentability — Anticipation — Infringement as test (§51.211)

Accused infringer's employment of process of dominating patent is not anticipation of invention described and claimed in improvement patent.

25. Patentability — Anticipation — In general (§51.201)

Patentability — Invention — In general (§51.501)

Inherency and obviousness are distinct concepts.

26. Patentability — Evidence of — In general (§51.451)

All evidence bearing on obviousness issue, as with any other issue raised in conduct of judicial process, must be considered and evaluated before required legal conclusion is reached.

27. Patentability — Evidence of — In general (§51.451)

Objective evidence of nonobviousness, i.e., "indicia" of *Graham v. John Deere Co.*, 148 USPQ 459, may in given case be entitled to more weight or less, depending on its nature and its relationship to invention's merits; it may be most pertinent, probative, and revealing evidence available to aid in reaching conclusion on obvious/nonobvious issue.

28. Patentability — Evidence of — Commercial success — In general (§51.4551)

Praise greeting products claimed in patent from suppliers, including owner of prior art

patent, is objective evidence of nonobviousness.

29. Patentability — Composition of matter (§51.30)

Claim to new product is not required to include critical limitations.

30. Specification — Sufficiency of disclosure (§62.7)

Patents are written to enable those skilled in art to practice invention, not public, and Section 112 speaks as of application filing date, not as of time of trial.

31. Specification — Sufficiency of disclosure (§62.7)

Section 112 requires that inventor set forth best mode of practicing invention known to him at time application was filed.

32. Claims — Indefinite — In general (§20.551)

Use of "stretching at rate exceeding specific percent per second" in claims is not indefinite.

33. Claims — Specification must support (§20.85)

It is claimed invention for which enablement is required.

34. Specification — Sufficiency of disclosure (§62.7)

Patent is not invalid merely because some experimentation is needed; patent is invalid only when those skilled in art are required to engage in undue experimentation to practice invention.

35. Construction of specification and claims — Claim defines invention (§22.30)

Distinguishing what infringes from what does not is role of claims, not of specification.

36. Construction of specification and claims — Defining terms (§22.45)

Patent applicant can be his own lexicographer.

37. Defenses — Fraud (§30.05)

Fraud must be shown by clear and convincing evidence; state of mind of one making representations is most important of elements to be considered in determining existence of fraud; good faith and subjective intent, while they are to be considered, should not necessarily be made controlling; under ordinary circumstances, fact of misrepresentation coup-

led with proof that party making it had knowledge of its falsity is enough to warrant drawing inference that there was fraudulent intent; where public policy demands complete and accurate disclosure it may suffice to show nothing more than that misrepresentations were made in atmosphere of gross negligence as to their truth.

38. Pleading and practice in courts — Issues determined — Validity and infringement (§53.505)

Better practice is for district court to decide both validity and infringement issues when both are contested at trial, enabling conduct of single appeal and disposition of entire case in single appellate opinion.

39. Infringement — Tests of — Comparison with claim (§39.803)

Infringement is decided with respect to each asserted claim as separate entity.

Particular patents — Porous Products

3,953,566, Gore, Process for Producing Porous Products, holding of invalidity of claims 3 and 19 reversed and of claims 1 and 17 affirmed.

4,187,390, Gore, Porous Products and Process Therefor, holding of invalidity reversed.

Appeal from District Court for the Northern District of Ohio, Manos, J.; 220 USPQ 220.

Consolidated actions by W. L. Gore & Associates, Inc., against Garlock, Inc., for patent infringement, in which defendant counterclaims for declaratory judgment of patent invalidity, noninfringement, fraudulent solicitation, and entitlement to attorney fees. From judgment for defendant, plaintiff appeals and defendant cross-appeals. Affirmed in part, reversed in part, and remanded; Davis, Circuit Judge, concurring in result in part and dissenting in part, with opinion.

David H. Pfeffer, New York, N.Y. (J. Robert Dailey and Janet Dore, both of New York, N.Y., and John S. Campbell, Newark, Del., of counsel) for appellant.

John J. Mackiewicz, Philadelphia, Pa. (Dale M. Heist, Philadelphia, Pa., on the brief, Bernard Ouziel, New York, N.Y., of counsel) for appellee.

Before Markey, Chief Judge, and Davis and Miller, Circuit Judges.

Markey, Chief Judge.

Appeal from a judgment of the District Court for the Northern District of Ohio holding U.S. Patents 3,953,566 ('566) and 4,187,390 ('390) invalid. We affirm in part, reverse in part, and remand for a determination of the infringement issue.

Background

Tape of unsintered polytetrafluorethylene (PTFE) (known by the trademark TEFLON of E.I. du Pont de Nemours, Inc.) had been stretched in small increments. W. L. Gore & Associates, Inc. (Gore), assignee of the patents in suit, experienced a tape breakage problem in the operation of its "401" tape stretching machine. Dr. Robert Gore, Vice President of Gore, developed the invention disclosed and claimed in the '566 and '390 patents in the course of his effort to solve that problem. The 401 machine was disclosed and claimed in Gore's U.S. Patent 3,664,915 ('915) and was the invention of Wilbert L. Gore, Dr. Gore's father. PTFE tape had been sold as thread seal tape, i.e., tape used to keep pipe joints from leaking. The '915 patent, the application for which was filed on October 3, 1969, makes no reference to stretch rate, at 10% per second or otherwise, or to matrix tensile strength in excess of 7,300 psi.

Dr. Gore experimented with heating and stretching of highly crystalline PTFE rods. Despite slow, careful stretching, the rods broke when stretched a relatively small amount. Conventional wisdom in the art taught that breakage could be avoided only by slowing the stretch rate or by decreasing the crystallinity. In late October 1969, Dr. Gore discovered, contrary to that teaching, that stretching the rods as fast as possible enabled him to stretch them to more than ten times their original length with no breakage. Further, though the rod was thus greatly lengthened, its diameter remained virtually unchanged throughout its length. The rapid stretching also transformed the hard, shiny rods into rods of a soft, flexible material.

Gore developed several PTFE products by rapidly stretching highly crystalline PTFE, including: (1) porous film for filters and laminates; (2) fabric laminates of PTFE film bonded to fabric to produce a remarkable material having the contradictory properties of impermeability to liquid water and permeability to water vapor, the material being used to make "breathable" rainwear, and filters; (3) porous yarn for weaving and braiding into other products, like space suits and pump packing; (4) tubes used as replacements for human arteries and veins; and (5) insulation for high performance electric cables.

On May 21, 1970, Gore filed the patent application that resulted in the patents in suit. The '566 patent has 24 claims directed to processes for stretching highly crystalline, unsintered, PTFE. The processes, inter alia, include the steps of stretching PTFE at a rate above 10% per second and at a temperature between about 35°C and the crystalline melt point of PTFE. The '390 patent has 77 claims directed to various products obtained by processes of the '566 patent.

It is effectively undisputed that the present inventions filled a long sought yet unfilled need. The United States Army and the research director of a Garlock Inc. (Garlock) customer had been looking for and following up every remote lead to a waterproof/breathable material for many years.

It is undisputed that the present inventions enjoyed prompt and remarkable commercial success due to their merits and not to advertising or other extraneous causes.

It is undisputed that the inventions provide the most important synthetic material available for use in vascular surgery, hundreds of thousands of persons having received artificial arteries formed of the patented products since 1976, and that the patented products have unique properties useful in other medical procedures, in communications satellites, radar systems, and electrical applications.

It is undisputed that the major sources of PTFE, ICI and du Pont, greeted the patented products as "magical," "bewitching," "a remarkable new material," and one that "differs from other processed forms of Teflon."

It is undisputed that the patented products were met with skepticism and disbelief by at least one scientist who had worked with PTFE at du Pont for many years and who testified as an expert at trial.

It is undisputed that Garlock first produced an accused product in response to a customer's request for a substitute for the patented product, that Garlock advertised its accused product as a "new form" of PTFE and as "a versatile new material which provides new orders of performance for consumer, industrial, medical and electrical applications," and that the customer describes that accused product as "a new dimension in rainproof/breathable fabrics."

Proceedings

On Nov. 2, 1979, Gore sued Garlock for infringement of process claims 3 and 19 of the '566 patent, and sought injunctive relief, damages and attorney fees. Garlock counterclaimed on Dec. 18, 1979, for a declaratory judgment of patent invalidity, non-infringe-

ment, fraudulent solicitation, and entitlement to attorney fees. On Feb. 7, 1980, Gore filed a second suit for infringement of product claims 14, 18, 36, 43, 67 and 77 of the '390 patent. In light of a stipulation, the district court consolidated the two suits for trial.

Gore alleged infringement of certain claims by certain products:

'566 patent claims	'390 patent claims	Garlock Product
19	14,43	film
--	36,77	laminate
19	18	yarn
--	67	braided packing
3	--	tape

At trial, Garlock addressed only claims 1, 3, 17, and 19 of the '566 patent and claims 1, 9, 12, 14, 18, 35, 36, 43, 67 and 77 of the '390 patent. See Appendix to this opinion.

The district court, in a thorough memorandum accompanying its judgment, and in respect of the '566 patent: (1) found claim 1 anticipated under 35 U.S.C. §102(a) by Gore's use of its 401 machine and use by the Budd Company (Budd) of a Cropper machine; (2) declared all claims of the patent invalid under 102(b) because the invention had been in public use and on sale more than one year before Gore's patent application, as evidenced by Budd's use of the Cropper machine; (3) held claims 1, 3, 17 and 19 invalid for obviousness under 35 U.S.C. §103, on the basis of various reference pairings: (a) Japanese patent 13560/67 (Sumitomo) with U.S. patent 3,214,503 (Markwood); (b) U.S. patent 2,776,465 (Smith) with Markwood; or (c) Gore's '915 patent with Sumitomo; and (4) held all claims invalid as indefinite under 35 U.S.C. §112.

35 U.S.C. §102(a) and (b) provide:

A person shall be entitled to a patent unless —

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or * * *

35 U.S.C. §103 provides:

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

In its opinion respecting the '390 patent, the district court held: (1) claims 1, 9, 12, 14, 18, 35, 36, 43, 67 and 77 invalid §§102 and 103 in view of Sumitomo and Smith; and (2) all claims invalid as indefinite under §112.

The court found that Gore did not commit fraud before the Patent and Trademark Office (PTO), denied Garlock's request for attorney fees, and refrained from deciding the infringement issue.

Issues

Did the district court err in: (1) its holding of invalidity under §§102(a), 102(b), 103 and 112; (2) its finding that Gore did not commit fraud on the PTO; or (3) denying attorney fees.

Opinion

This hard fought and bitterly contested case involved over two years of discovery, five weeks of trial, the testimony of 35 witnesses (19 live, 16 by deposition), and over 300 exhibits. The district court issued an exhaustive 37-page memorandum opinion, reflective of a careful, conscientious approach to the determination of the many issues presented at trial.

The record on appeal consists of 2000 pages. The parties' briefs total 199 pages. In those briefs, counsel repeatedly accuse each other of numerous and serious breaches of the duty of candor owed the court. Each cites instances in which the testimony, the findings, and the record are or are said to be quoted in part and out of context. As a result, the usefulness and reliability of the briefs as means of informing the court has been greatly diminished if not destroyed, and careful, time-consuming study of all exhibits and each page of the record has been required.

35 U.S.C. §112 provides:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention. A claim may be written in independent or dependent form, and if in dependent form, it shall be construed to include all the limitations of the claim incorporated by reference into the dependent claim.

Appellant cited 80 prior court opinions in its main brief. Appellee's brief totally ignores all but two of those citations, but adds 57 more. Appellant's reply brief cites 126 prior court opinions, 34 earlier cited, 67 newly cited, and 25 of those cited by appellee. Appellee's reply brief cites 17 prior court opinions, 4 earlier cited, 7 newly cited, and 6 of the 147 cited by appellant. Accordingly, 211 prior court opinions have been evaluated in relation to the proof found in the record.

In light of the entire record and the applicable law, we are convinced that Garlock failed to carry its burden of proving all claims of the present patents invalid.

Standard of Review

[1,2] Where, as here, dispositive legal error occurred in interpretation and application of the patent statute, 35 U.S.C., the parties' arguments relating to the salutary injunction of Fed. Rule Civ. P. 52(a) cannot be controlling on all issues. Though findings that "rest on an erroneous view of the law may be set aside on that basis," *Pullman-Standard v. Swint*, 456 U.S. 273 (1982), it is unnecessary here to set aside any probative fact found by the district court or to engage in what would be an inappropriate reweighing of the facts.

Among the legal errors extant in the record, each of which is discussed below, are (1) the invention set forth in each claim was not in each instance considered as a whole; (2) 35 U.S.C. §102(b) was applied though criteria for its application were not present; (3) the references were not assessed in their entireties; (4) an inherency theory under §§102 and 103 was inappropriately applied; (5) that which only the inventor taught was attributed to the prior art; (6) individual steps in prior art processes dealing with materials distinct from those with which the present inventions dealt were erroneously equated to steps in the claimed processes; (7) objective evidence of nonobviousness was disregarded; and (8) the function and application of §112 were misconstrued.

Because it permeated so much of the district court's analysis, we note more fully its frequent restriction of its consideration to 10% per second rate of stretching, which it called the "thrust of the invention." That approach is repeated throughout Garlock's briefs, which refer repeatedly to the "thrust of the invention," to "the inventive concept," and to the claims "shorn of their extraneous limitations." That facile focusing on the "thrust," "concept," and "shorn" claims, resulted in treating the claims at many points as though they read differently from those actually allowed and in suit.

[3] It is true that Dr. Gore emphasized rapid stretching, for example, as well as the amount of stretch and other process limitations, during prosecution of the application for the '566 patent. Yet it is the claims that measure and define the invention. *Aro Manufacturing Co. v. Convertible Top Replacement Co.*, 365 U.S. 336, 339, 128 USPQ 354 (1961); *Bowser, Inc. v. U.S.*, 388 F.2d 346, 349, 156 USPQ 406, 409 (Ct. Cl. 1967).

[4] Each claimed invention must be considered as a whole. 35 U.S.C. §103; *Schenck, A.G. v. Nortron Corp.*, 218 USPQ 698, 700 (Fed. Cir. 1983). In determining obviousness, there is "no legally recognizable or protected 'essential,' 'gist,' or 'heart' of the invention." *Aro*, 365 U.S. at 345. A court's restriction of a claimed multi-step process to one step constitutes error, whether done at the behest of a patentee relying on that restriction to establish infringement by one who employs only that one step in a process otherwise distinct, or at the behest of an accused infringer relying on that restriction to establish invalidity by showing that one step in a prior art process otherwise distinct.

(1) Invalidity

(a) '566 Patent

(i) §102(a) and The 401 Machine

It is undisputed that the district court held only claim 1 of the '566 patent to have been anticipated under §102(a) by operation of the 401 machine in the Gore shop before Dr. Gore's invention in late October 1969. It did so on the deposition testimony of two former Gore employees, documents, and drawings of the 401 machine.

In August 1969, Gore offered to sell to Export Tool Company (Export) tape "to be made" on the 401 machine. Tape made on the 401 machine was shipped to Export on October 24, 1969. The trial judge found the rolls on the 401 machine were, at least at some point in time before October 1969, spaced less than four feet apart and that the rate of stretch accomplished in operating that machine (admittedly operated in accord with the description of machine operation in the '915 patent) must have been greater than 10% per second. The district court credited testimony that Teflon 6-c, a highly crystalline form of Teflon, was used because it was the standard resin at the time, and that the tape was stretched at a temperature above 35°C. Thus it cannot be said that the record fails to support the district court's finding that the

limitations of claim 1 were met by Gore's operation of the 401 machine before Dr. Gore's asserted "late October 1969" date of invention. Though he was working with the operation of the 401 machine, Dr. Gore offered no proof that his invention date was before the date of shipment to Export.

[5] Gore, seeking a review here of the evidence, points to certain inadequacies as indicating a failure to meet the required clear and convincing standard under §102(a). At the time of trial, the district court, bound by precedent then applicable, applied a preponderance of the evidence test. Gore asserts, erroneously, that the clearly erroneous standard does not therefore apply on this appeal. Gore does not, however, point to any basis on which the district court's findings must be held to have been clearly erroneous under the clear and convincing standard. We are not at liberty, of course, to substitute our own for the district court's findings underlying its conclusion that claim 1 is invalid.

[6] Gore's operation of the 401 machine must thus be viewed as a consistent, reproducible use of Dr. Gore's invention as set forth in claim 1, and it is therefore irrelevant that those using the invention may not have appreciated the results. *General Electric Co. v. Jewel Incandescent Lamp Co.*, 326 U.S. 242, 248, 67 USPQ 155, 157-58 (1945). Were that alone enough to prevent anticipation, it would be possible to obtain a patent for an old and unchanged process. *Ansonia Brass & Copper Co. v. Electric Supply Co.*, 144 U.S. 11, 18 (1892); see, *H.K. Regar & Sons, Inc. v. Scott & Williams, Inc.*, 63 F.2d 229, 231, 17 USPQ 81, 83 (2d Cir. 1933).

[7] The nonsecret use of a claimed process in the usual course of producing articles for commercial purposes is a public use. *Electric Storage Battery Co. v. Shimadzu*, 307 U.S. 5, 20, 41 USPQ 155, 161 (1939), and there was no evidence that any different process was used to produce the articles shipped to Export.

Thus it cannot be said that the district court erred in determining that the invention set forth in claim 1 of '566 patent was known or used by others under §102(a), as evidenced by Gore's operation of the 401 machine before Dr. Gore's asserted date of that invention.

In view of our affirmance of the judgment reached on claim 1 under 102(a), we need not discuss other asserted grounds of invalidity of claim 1. There was, however, no evidence whatever that the inventions set forth in other claims, of either the '566 or the '390 patent, were known or used by others as a result of Gore's operation of the 401 machine before late October 1969.

(ii) §102(b) and the Cropper Machine

In 1966 John W. Cropper (Cropper) of New Zealand developed and constructed a machine for producing stretched and unstretched PTFE thread seal tape. In 1967, Cropper sent a letter to a company in Massachusetts, offering to sell his machine, describing its operation, and enclosing a photo. Nothing came of that letter. There is no evidence and no finding that the present inventions thereby became known or used in this country.

In 1968, Cropper sold his machine to Budd, which at some point thereafter used it to produce and sell PTFE thread seal tape. The sales agreement between Cropper and Budd provided:

ARTICLE "E" - PROTECTION OF TRADE SECRETS Etc.

1. BUDD agrees that while this agreement is in force it will not reproduce any copies of the said apparatus without the express written permission of Cropper nor will it divulge to any person or persons other than its own employees or employees of its affiliated corporations any of the said known-how or any details whatsoever relating to the apparatus.

2. BUDD agrees to take all proper steps to ensure that its employees observe the terms of Article "E" 1 and further agrees that whenever it is proper to do so it will take legal action in a Court of competent jurisdiction to enforce any one or more of the legal or equitable remedies available to a trade secret plaintiff.

Budd told its employees the Cropper machine was confidential and required them to sign confidentiality agreements. Budd otherwise treated the Cropper machine like its other manufacturing equipment.

A former Budd employee said Budd made no effort to keep the secret. That Budd did not keep the machine hidden from employees legally bound to keep their knowledge confidential does not evidence a failure to maintain the secret. Similarly, that du Pont employees were shown the machine to see if they could help increase its speed does not itself establish a breach of the secrecy agreement. There is no evidence of when that viewing occurred. There is no evidence that a viewer of the machine could thereby learn anything of which process, among all possible processes, the machine is being used to practice. As Cropper testified, looking at the machine in operation does not reveal whether it is stretching, and if so, at what speed. Nor does looking disclose whether the crystallinity and temperature elements of the invention set

forth in the claims are involved. There is no evidence that Budd's secret use of the Cropper machine made knowledge of the claimed process accessible to the public.

The district court held all claims of the '566 patent invalid under 102(b), supra, note 3, because "the invention" was "in public use [and] on sale" by Budd more than one year before Gore's application for patent. Beyond a failure to consider each of the claims independently, 35 U.S.C. §282; *Altoona Publix Theatres, Inc. v. American Tri-Ergon Corp.*, 294 U.S. 477, 487, 24 USPQ 308 (1935), and a failure of proof that the claimed inventions as a whole were practiced by Budd before the critical May 21, 1969 date, it was error to hold that Budd's activity with the Cropper machine, as above indicated, was a "public" use of the processes claimed in the '566 patent, that activity having been secret, not public.

Assuming, arguendo, that Budd sold tape produced on the Cropper machine before October 1969, and that that tape was made by a process set forth in a claim of the '566 patent, the issue under §102(b) is whether that sale would defeat Dr. Gore's right to a patent on the process inventions set forth in the claims.

[8] If Budd offered and sold anything, it was only tape, not whatever process was used in producing it. Neither party contends, and there was no evidence, that the public could learn the claimed process by examining the tape. If Budd and Cropper commercialized the tape, that could result in a forfeiture of a patent granted them for their process on an application filed by them more than a year later. *D.L. Auld Co. v. Chroma Graphics Corp.*, No. 83-585, slip op. at 5-6 (Fed. Cir. Aug. 15, 1983); See *Metalizing Engineering Co. v. Kenyon Bearing & Auto Parts Co.*, 153 F.2d 516, 68 USPQ 54 (2d Cir. 1946). There is no reason or statutory basis, however, on which Budd's and Cropper's secret commercialization of a process, if established, could be held a bar to the grant of a patent to Gore on that process.

[9,10] Early public disclosure is a linchpin of the patent system. As between a prior inventor who benefits from a process by selling its product but suppresses, conceals, or otherwise keeps the process from the public, and a later inventor who promptly files a patent application from which the public will gain a disclosure of the process, the law favors the latter. See *Horwath v. Lee*, 564 F.2d 948, 195 USPQ 701 (CCPA 1977). The district court therefore erred as a matter of law in applying the statute and in its determination that Budd's secret use of the Cropper machine and sale of tape rendered all process

claims of the '566 patent invalid under §102(b).

(iii) §103

In considering claims 1, 3, 17, and 19 of the '566 patent, the district court recognized that analysis of the obviousness issue under §103 requires determination of the scope and content of the prior art, the differences between the prior art and the claims at issue, and the level of ordinary skill in the pertinent art. *Graham v. John Deere Co.*, 383 U.S. 1, 17, 148 USPQ 459, 467 (1966).

[11,12,13] In its consideration of the prior art, however, the district court erred in not taking into account the import of the markedly different behavior of PTFE from that of conventional thermoplastic polymers clearly established and undisputed on the record, and in thus disregarding the unpredictability and unique nature of the unsintered PTFE to which the claimed inventions relate. In *re* *Whiton*, 420 F.2d 1082, 164 USPQ 455 (CCPA 1970); in considering claims in less than their entirety, *Schenck*, *supra*; and in considering the references in less than their entirety, i.e., in disregarding disclosures in the references that diverge from and teach away from the invention at hand. In *re* *Kuderna*, 426 F.2d 385, 165 USPQ 575 (CCPA 1970).

Invalidity of claim 1 under §102(a) having been determined, it is unnecessary to discuss in detail the applicability of §103 to that claim. If claim 1 had not been held anticipated under §102(a) in light of operation of the 401 machine, it is clear from the discussion here that claim 1 could not properly have been held invalid under §103.

Claim 3 depends from and thus incorporates claim 1 but specifies a rate of stretch of 100% per second. Claim 17 also depends from claim 1 and specifies an amount of stretch of about twice the original length. Claim 19 depends from claim 17 but specifies an amount of stretch of about five times the original length.

U.S. patent 2,983,961 to Titterton, Volume 13 of the *Encyclopedia of Polymer Science and Technology* (1970), the Sumitomo patent, and witnesses for both parties, establish that teachings related to conventional thermoplastic polymers are inapplicable to PTFE.

Articles by Dogliotti and Yelland, *Effect of Strain Rate on the Viscoelastic Properties of High Polymeric Fibrous Materials*, 4 *High Speed Testing* 211 (1964) and Robinson and Graham, *Methods of Characterization of Polymeric Materials by High Speed Testing Techniques*, 5 *High Speed Testing* 261

(1965), teach that conventional plastics and sintered PTFE can be stretched further if stretched slowly. Dr. Gore demonstrated at trial and at oral argument before us that an attempt to stretch highly crystalline, unsintered PTFE slowly results in breakage, and that rapid stretching produces a greatly lengthened rod of soft, flexible material.

The '566 patent contains an example of stretching an article to 16 times its length. Smith and the '915 patent teach that PTFE could not be stretched beyond four times its length without heating it to above its crystalline melt temperature, a step avoided by Dr. Gore and as set forth in the claims.

Sumitomo teaches that there is a length limit to stretching unsintered PTFE, and does not suggest what that limit might be. Markwood, U.S. patent 3,208,100 to Nash (Nash), and U.S. patent 2,823,421 to Scarlett (Scarlett) teach that *non-PTFE* thermoplastics can be stretched rapidly and to extended lengths, and also teach reduction, elimination, or avoidance of crystallinity before stretching.

The disclosure in the Smith and '915 patents that a PTFE article may be stretched to as much as four times its length encompasses the step of stretching to twice its length set forth in claim 17 and establishes that such step would have been obvious.

[14] Claims 3 and 19 must be considered individually and separately. 35 U.S.C. §282. Nowhere, in any of the references, is it taught or suggested that highly crystalline, unsintered PTFE could be stretched at a rate of about 100% per second as required by asserted claim 3. Nor is it anywhere suggested that by rapid stretching a PTFE article be stretched to more than five times its original length as required by asserted claim 19. On the contrary, the art as a whole teaches the other way.

[15] In concluding that obviousness was established by the teachings in various pairs of references, the district court lost sight of the principle that there must have been something present in those teachings to suggest to one skilled in the art that the claimed invention before the court would have been obvious. In *re* *Bergel*, 292 F.2d 955, 956-57, 130 USPQ 206, 208 (CCPA 1961); In *re* *Sponnoble*, 405 F.2d 578, 585, 160 USPQ 237, 244 (CCPA 1969).

The court's pairing of Sumitomo and Markwood disregarded, as above indicated, the undisputed evidence that the unsintered PTFE of Sumitomo does not respond to the conventional plastics processing of Markwood and the art recognition of that fact. *Whiton*, *supra*, 420 F.2d at 1085, 164 USPQ at 457.

In evaluating claim 19, for example, the pairing disregarded Sumitomo's limited

length of stretch teaching. In evaluating claim 3, the court recognized that Sumitomo made no mention of rate of stretch. Looking to Markwood to supply that teaching disregarded not only the conventional plastics-unsintered PTFE distinction but also the clear divergence of Markwood's teaching that crystallinity must be reduced or avoided from the presence of "highly crystalline" in all claims of the '566 patent.

Similarly, and for many of the same reasons, the pairing of Markwood's and Smith's teachings was an inappropriate basis for concluding that the processes set forth in claims 3 and 19 would have been obvious. As above indicated, Markwood's rapid stretching of conventional plastic polypropylene with reduced crystallinity would not suggest rapid stretching of highly crystalline PTFE, in light of teachings in the art that PTFE should be stretched slowly. The Smith patent is owned by du Pont, where Dr. Gore's process invention was considered to have produced a "remarkable new material." That circumstance is not surprising, for Smith, though dealing with PTFE, says not a word about any rate of stretch.

Lastly, the pairing of Sumitomo and the '915 patent suffers from the same shortcomings. The pairing resulted from a hypothetical set forth in Garlock's post trial brief, and was based on no testimony or other evidence in the record. In respect to claim 3, neither reference mentions rate of stretch or suggests its importance. In respect of claim 19 both references point away from the claimed invention in their limited length-of-stretch teachings. The '915 patent states: "the 65 percent expanded material could be expanded a second time for an additional 65 percent expansion or a total length increase ratio of 1:2.72 [less than three times the original length]. However, great care was necessary to obtain a uniformly expanded material at these very great expansion ratios." Thus the '915 patent suggests that the amount of stretch of 500% set forth in claim 19 (more than five times the original length) is not possible.

As indicated, Sumitomo and Smith are totally silent respecting the rate of stretch, and there is simply no teaching in the art that would suggest to one of ordinary skill that Markwood's fast stretching of other thermoplastics could or should be employed in the process of treating PTFE taught by either Sumitomo or Smith. Indeed, Smith not only says nothing about rate of stretch, its preferred teaching is away from other elements of the inventions set forth in claims 3 and 19. Smith discloses that stretching should be done after the PTFE is heated above its crystalline

melting point and with decreased crystallinity. Smith teaches:

Below about 300°C it is *not possible* to draw more than about 4X [times] and while such draw ratios can be attained around 300°C and below the polymer's crystalline melting point with resultant orientation and improved properties it is preferred to use temperatures at or above the polymer's crystalline melting point. (Emphasis added).

Nash teaches that the film should be plasticized, i.e., made more viscous, before stretching. Contrary to that teaching, Dr. Gore did not reduce crystallinity before increasing the rate of stretch, but maintained the unsintered PTFE "highly crystalline" while stretching at a 100% per second rate and to more than five times, as set forth respectively in claims 3 and 19.

[16] On the entire record and in view of all the references, each in its entirety, it is clear that a person of ordinary skill confronted with a PTFE tape breakage problem would have either slowed the rate of stretching or increased the temperature to decrease the crystallinity. Dr. Gore did neither. He proceeded contrary to the accepted wisdom of the prior art by dramatically increasing the rate and length of stretch *and* retaining crystallinity. That fact is strong evidence of nonobviousness. *United States v. Adams*, 383 U.S. 39 (1966).

Having learned the details of Dr. Gore's invention, the district court found it within the skill of the art to stretch other material rapidly (Markwood); to stretch PTFE to increase porosity (Sumitomo); and to stretch at high temperatures (Smith). The result is that the claims were used as a frame, and individual, naked parts of separate prior art references were employed as a mosaic to recreate a facsimile of the claimed invention. At no point did the district court, nor does Garlock, explain why that mosaic would have been obvious to one skilled in the art in 1969, or what there was in the prior art that would have caused those skilled in the art to disregard the teachings there found against making just such a mosaic. On the contrary, the references and the uncontested testimony, as above indicated, established that PTFE is *sui generis*. It is not surprising, therefore, that, unlike the situation in *Stratoflex, Inc. v. Aeroquip Corp.*, 218 USPQ 871 (Fed. Cir. 1983), there was no testimony and no finding that one skilled in the art would transfer conventional thermoplastic processes to those for unsintered PTFE, or would have been able to predict what would happen if they did.

[17] To imbue one of ordinary skill in the art with knowledge of the invention in suit,

when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher.

[18] It is difficult but necessary that the decisionmaker forget what he or she has been taught at trial about the claimed invention and cast the mind back to the time the invention was made (often as here many years), to occupy the mind of one skilled in the art who is presented only with the references, and who is normally guided by the then-accepted wisdom in the art. Had that been here done the inventions set forth in the claims 3 and 19 of the '566 patent could only have been held non-obvious to those skilled in the art at the time those claimed inventions were made.

[19] Error in visualizing the burden of proof on obviousness may have contributed to the court's application here of the prior art. Adopting the phrase from earlier precedents, the court said "the presumption [of validity] is weakened greatly where the Patent Office has failed to consider pertinent prior art." That is not the law of established precedent in this court. *SSIH Equipment S.A. v. ITC*, 218 USPQ 678, 687 (Fed. Cir. 1983); *Solder Removal Co. v. ITC*, 582 F.2d 628, 633, 199 USPQ 129, 133, n. 9 (CCPA 1978). The presumption has no separate evidentiary value. It cautions the decisionmaker against a rush to conclude invalidity. Submission of additional art that is merely "pertinent" does not dispel that caution. It is difficult to imagine a patent law suit in which an accused infringer is unable to add some new "pertinent" art. The inescapable burden of persuasion on one who would prove invalidity, however, remains throughout the trial. 35 U.S.C. §282.

[20] The burden of proving invalidity may of course be facilitated by prior art that is *more pertinent* than that considered by the PTO. That did not happen here. In the present case, Sumitomo, Smith, and the '915 patent were among references considered by the PTO. Other references referred to as not considered were merely cumulative, disclosing nothing not disclosed in references that were considered by the PTO. The Canadian counterpart of Nash was considered by the PTO. The relevant disclosures of Markwood appear in Sandiford patent 3,544,671 and Parathion patent 3,637,906, both considered by the PTO. The Russian Author's Certificate 240,997, assuming its status as prior art and whatever the material with which it dealt, contributed nothing beyond the teachings of the '915 patent considered by the PTO.

[21] As discussed more fully below, the district court erred in specifically declining to

consider the objective evidence of nonobviousness. In *re Sernaker*, 702 F.2d 989, 996, 217 USPQ 1, 7 (Fed. Cir. 1983). That evidence can often serve as insurance against the insidious attraction of the siren hindsight when confronted with a difficult task of evaluating the prior art. Though the prior art evidence here pointed more in the direction of nonobviousness than obviousness, the objective evidence may tend, as it did in *Sernaker*, supra, to reassure the decisionmaker.

In sum, the district court erred as a matter of law on this record in concluding that Garlock had met its burden of proving that the inventions of claims 3 and 19 of the '566 patent would have been obvious.

(b) '390 patent

(i) §102

The district court found product claims 1, 9, 12, 14, 18 and 43 inherently anticipated because it found that the microstructure of nodes interconnected by fibrils is an inherent characteristic of paste-extruded PTFE products resulting from the process disclosed in Smith. The court found the first four of those claims and claim 43, plus claims 35, 36, 67 and 77 inherently anticipated because high strength PTFE products are inherent in the examples of Sumitomo.

The teachings of Smith include neither a disclosure nor a suggestion of "porous" products having a "microstructure characterized by nodes interconnected by fibrils" as required by the claims found to have been anticipated by Smith.

The teachings of Sumitomo do not include a disclosure of products having "a matrix tensile strength *** above about 7,300 psi" as required by the claims found to have been anticipated by Sumitomo.

[22] Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration. *Soundsciber Corp. v. U.S.*, 360 F.2d 954, 960, 148 USPQ 298, 301, adopted, 149 USPQ 640 (Ct. Cl. 1966). Neither Smith nor Sumitomo disclose an invention set forth in any claim of the '390 patent.

The incongruity in findings that the different processes of Smith and Sumitomo each inherently produced identical products is striking.

Garlock attempted with expert testimony to overcome the prior art shortcomings as proof of anticipation. Gore rebutted with its own expert testimony. It is unnecessary, however, to resolve apparent conflicts in the divergent testimony, much if not all of which took

the form of pure unsupported assertion. No inter partes tests in which the Smith and Sumitomo processes were conducted are of record. No products of those processes were placed in evidence, and there was, of course, no analysis of any such evidentiary products.

Nor is it necessary to evaluate the inappropriate disparagement in Garlock's brief of Dr. Sperati as a "friend" of Gore.

[23] Given the unique nature of unsintered PTFE, we are not persuaded that the "effect" of the processes disclosed in Smith and Sumitomo, an "effect" undisclosed in those patents, would be always to inherently produce or be seen always to produce products meeting all of the claim limitations. Anticipation of inventions set forth in product claims cannot be predicated on mere conjecture respecting the characteristics of products that might result from the practice of processes disclosed in references. In *re Felton*, 484 F.2d 495, 500, 179 USPQ 295, 298 (CCPA 1973). It is clear that the teachings of neither Smith nor Sumitomo place the products claimed in the '390 patent in possession of the public.

The teachings of Smith and Sumitomo are so unacceptably vague concerning characteristics of products produced by their respective processes as not to support an anticipation rejection. That fact is confirmed by the PTO's having fully considered those references and by its having issued the '390 patent over them.

[24] Garlock's assertion that it employs a process covered by the Smith patent, if true, is irrelevant. The '390 patent was allowed over Smith as a reference. Assuming Smith is a dominating patent, the rule of law is clear that an accused infringer's employment of the process of a dominating patent does not render that employment an anticipation of an invention described and claimed in an improvement patent. As indicated, there is no present record basis for finding that the Smith process in itself necessarily and inherently results in the products, each considered in its entirety, in the claims of the '390 patent. The testimony of Garlock's expert about *ex parte* tests, the records of which he destroyed before trial, cannot serve as such a basis. The effusive praise of Dr. Gore's claimed products by the owner of the Smith patented process would appear, on the contrary, to confirm the action of the PTO in issuing the '390 patent.

Garlock has not met its burden of showing that claims 1, 9, 12, 14, 18, and 43 are anticipated by Smith or that claims 1, 9, 12, 14, 35, 36, 43, 67, and 77 are anticipated by Sumitomo.

(ii) §103.

[25] The scope and content of the prior art and level of ordinary skill, discussed above in relation to the '566 patent, would be the same for the '390 patent. The district court did not, however, nor does Garlock, apply the Graham criteria, *supra*, to the '390 claims, apparently assuming that the claimed products, having been found inherent in the processes of Sumitomo and Smith, would have been obvious in view of those references. If so, that was error. Inherency and obviousness are distinct concepts. In *re Spormann*, 363 F.2d 444, 448, 150 USPQ 449, 452 (CCPA 1966).

In discussing inherency the district court did recognize differences between Smith's disclosure and the inventions set forth in claims 1, 9, 12, 14, 18, and 43, i.e., the absence from Smith of a description of the products of Smith's process as porous and the absence from Smith of a disclosure that those products have a microstructure characterized by nodes interconnected by fibrils.

Similarly, a difference between Sumitomo's disclosure and the inventions set forth in claims 1, 9, 12, 14, 35, 36, 43, 67, and 77 was recognized in the absence from Sumitomo of a quantification of the matrix tensile strengths of the products of Sumitomo's process. The district court also discussed differences between the dependent claims and the prior art. Because we conclude that the independent claims of the '390 patent are patentable over the art of record, we need not discuss the dependent claims.

[26] Having determined that the invention would have been obvious in view of the process of either Smith or Sumitomo, the district court did not discuss the strong showing of objective evidence of nonobviousness here present, saying with respect to one part of such evidence, "no amount of commercial success can save it." That approach was error. All evidence bearing on the issue of obviousness, as with any other issue raised in the conduct of the judicial process, must be considered and evaluated *before* the required legal conclusion is reached. *Stratoflex*, *supra*, 218 USPQ at 879.

[27] The objective evidence of nonobviousness, i.e., the "indicia" of Graham, *supra*, may in a given case be entitled to more weight or less, depending on its nature and its relationship to the merits of the invention. It may be the most pertinent, probative, and revealing evidence available to aid in reaching a conclusion on the obvious/nonobvious issue. It should when present always be considered as an integral part of the analysis.

Gore's fabric laminates, for example, as set forth in claims 36 and 77, satisfied a long-felt

need for a material having the contradictory properties of being simultaneously breathable (allowing water vapor or perspiration to pass) and waterproof. The record establishes that such a material had long been sought by makers of rainwear and outerwear, and by the U.S. Army as well. That Gore's fabric laminates filled that need is attested by the rise in their annual dollar sales from zero to seven million in the first five years of their availability.

Gore's PTFE tubes for replacement of human arteries and veins, also satisfied a long-felt need. The uncontradicted evidence establishes that Gore's PTFE tubes hold blood without leaking, need not be pre-clotted with the patient's blood, are chemically inert, and, being breathable, are less likely to cause an air embolism. The value and uniqueness of those four properties make Gore's PTFE tubes, as described in unchallenged testimony, "the most important synthetic material presently existing" in vascular surgery, and, along with other evidence in the record, reflect the intended working of the patent system.

As discussed above, current annual sales of over sixty million dollars are attributable to the merits of the products claimed in the '390 patent. Considering the long-felt need for those products and the obvious commercial advantage to be gained by meeting that need, it is reasonable to conclude that the claimed products of the '390 patent would not have been obvious to persons of ordinary skill in the art at the time the claimed inventions were made.

[28] As above indicated, the praise which greeted the products claimed in the '390 patent from PTFE suppliers, including the owner of the Smith patent, is further objective evidence of nonobviousness.

[29] Garlock's appeal argument that the '390 claims are invalid because the recited minimum matrix tensile strengths are not "critical" is without merit. A claim to a new product is not legally required to include critical limitations. In re Miller, 441 F.2d 689, 696, 169 USPQ 597, 602 (CCPA 1971). The '390 claims are not drawn to optimization of ingredients or ranges within broad prior art teachings, but to new porous PTFE products of particular characteristics.

In sum, and in view of the difficulty of working with unsintered PTFE and its unpredictable response to various processing techniques, the vagueness of Smith and Sumitomo concerning the products produced by those processes, the filling of at least two long-felt needs and the commercial success described above, we conclude that the inventions set forth in claims 1, 9, 12, 14, 18, 35, 36, 43, 67, and 77 of the '390 patent would

not have been obvious to those skilled in the art at the time those inventions were made.

(c) §112 and the '566 and '390 patents

The patents in suit resulted from a single application and thus have substantially identical specifications. The holding of invalidity on the basis of §112 is common to both patents.

The district court found that the patents did not disclose sufficient information to enable a person of ordinary skill in the art to make and use the invention, as required by §112, first paragraph, and that certain claim language was indefinite, presumably in light of §112, second paragraph, because: (1) there was no definition in the specification of "stretch rate," different formulae for computing stretch rate having been developed and presented at trial; (2) there was no way taught in the specification to calculate the minimum rate of stretch above 35°C; (3) the phrase "matrix tensile strength" is indefinite; and (4) the phrase "specific gravity of the solid polymer" is indefinite.

[30] The findings rest on a misinterpretation of §112, its function and purpose. The district court considered whether certain terms would have been enabling to the public and looked to formula developments and publications occurring well after Dr. Gore's filing date in reaching its conclusions under §112. Patents, however, are written to enable those skilled in the art to practice the invention, not the public. In re Storrs, 245 F.2d 474, 478, 114 USPQ 293, 296-97 (CCPA 1957), and §112 speaks as of the application filing date, not as of the time of trial. In re Mott, 539 F.2d 1291, 1296, 190 USPQ 536, 541 (CCPA 1976). There was no evidence and no finding that those skilled in the art would have found the specification non-enabling or the claim language indefinite on May 21, 1970, when the application which resulted in issuance of Dr. Gore's patents was filed. Indeed, the expert quoted by the district court and whose testimony was primarily relied upon respecting formulae, was still in school at that time.

There is uncontradicted evidence in the record that at the time the application was filed "stretch rate" meant to those skilled in the art the percent of stretch divided by the time of stretching, and that the latter was measurable, for example, with a stopwatch. Concern for the absence from the specification of a formula for calculating stretch rate is therefore misplaced, and the post-filing date development of varying formulae, including Dr. Gore's later addition of a formula in his corresponding Japanese patent, is irrelevant.

[31] Section 112 requires that the inventor set forth the best mode of practicing the invention known to him at the time the application was filed. Calculating stretch rate at that time was accomplished by actually measuring the time required to stretch the PTFE material. That was the only mode then used by the inventor, and it worked. The record establishes that calculation by that mode would have been employed by those of ordinary skill in the art at the time the application was filed. As indicated, Dr. Gore's disclosure must be examined for §112 compliance in light of knowledge extant in the art on his application filing date.

[32] The district court, though discussing enablement, spoke also of indefiniteness of "stretch rate," a matter having to do with §112, second paragraph, and relevant in assessment of infringement. The use of "stretching . . . at a rate exceeding about 10% per second" in the claims is not indefinite. Infringement is clearly assessable through use of a stopwatch. No witness said that could not be done. As above indicated, subsequently developed and therefore irrelevant formulae cannot be used to render non-enabling or indefinite that which was enabling and definite at the time the application was filed.

[33] Similarly, absence from the specification of a method for calculating the minimum rate of stretch above 35°C does not render the specification non-enabling. The specification discloses that "[t]he lower limit of expansion rates interact with temperature in a roughly logarithmic fashion, being much higher at higher temperatures." Calculation of minimum stretch rate above 35°C is nowhere in the claims, and it is the *claimed* invention for which enablement is required. The claims require stretching at a rate greater than 10% per second at temperatures between 35°C and the crystalline melt point of unsintered PTFE. That the minimum rate of stretch may increase with temperature does not render non-enabling Dr. Gore's specification, particularly in the absence of convincing evidence that those skilled in the art would have found it non-enabling at the time the application was filed.

[34] The district court invalidated both patents for indefiniteness because of its view that some "trial and error" would be needed to determine the "lower limits" of stretch rate above 10% per second at various temperatures above 35°C. That was error. Assuming some experimentation were needed, a patent is not invalid because of a need for experimentation. *Minerals Separation, Ltd. v. Hyde*, 242 U.S. 261, 270-71 (1916). A patent is invalid only when those skilled in the art are required to

engage in *undue* experimentation to practice the invention. In *re Angstadt*, 537 F.2d 498, 503-04, 190 USPQ 214, 218 (CCPA 1976). There was no evidence and the court made no finding that undue experimentation was required.

[35] Moreover, the finding here rested on confusion of the role of the specification with that of the claims. The court found that the specification's failure to state the lower limit of stretch rate (albeit above 10% per second) at each degree of temperature above 35°C (a requirement for at least hundreds of entries in the specification) did not "distinguish processes performed above the 'lower limit' from those performed below the 'lower limit'." The claims of the '390 patent say nothing of processes and lower limits. Distinguishing what infringes from what doesn't is the role of the claims, not of the specification. It is clear that the specification is enabling. In *re Storrs*, *supra*, and that the claims of both patents are precise within the requirements of the law. In *re Moore*, 439 F.2d 1232, 169 USPQ 236 (CCPA 1971).

[36] The finding that "matrix tensile strength" is indefinite, like the other findings under §112, appears to rest on a confusion concerning the roles of the claims and the specification. While finding "matrix tensile strength" in the claims indefinite, the district court at the same time recognized that the specification itself disclosed how to compute matrix tensile strength, in stating "to compute matrix tensile strength of a porous specimen, one divides the maximum force required to break the sample by the cross sectional area of the porous sample, and then multiplies this quantity by the ratio of the specific gravity of the solid polymer divided by the specific gravity of the porous specimen." Further, the specification provided the actual matrix tensile strength in several examples. It is well settled that a patent applicant may be his own lexicographer. In light of the disclosure of its calculation in the specification, we cannot agree that "matrix tensile strength" is either indefinite or non-enabling.

Nor does absence from the specification of a definition for "specific gravity of the solid polymer," a part of the computation of matrix tensile strength, render that computation indefinite. It is undisputed that in the many examples in the application the specific gravity values used for unsintered and sintered PTFE were 2.3 and 2.2, respectively. There was no testimony that those values were not known to persons of ordinary skill in the art or could not be calculated or measured. There is simply no support for the conclusion that "specific gravity of the solid polymer" is indefinite or that absence of its definition ren-

ders the specification non-enabling. See *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976).

We conclude that Garlock has failed to prove that at the time the application was filed, the specification was not enabling or that the claims were indefinite within the meaning of §112.

(2) Fraud

[37] Fraud must be shown by clear and convincing evidence. *Norton v. Curtiss*, 433 F.2d 779, 797, 167 USPQ 532, 546-47 (CCPA 1970).

The state of mind of the one making the representations is probably the most important of the elements to be considered in determining the existence of "fraud." *** Good faith and subjective intent, while they are to be considered, should not necessarily be made controlling. Under ordinary circumstances, the fact of misrepresentation coupled with proof that the party making it had knowledge of its falsity is enough to warrant drawing the inference that there was a fraudulent intent. Where public policy demands a complete and accurate disclosure it may suffice to show nothing more than that the misrepresentations were made in an atmosphere of gross negligence as to their truth. [emphasis in original].

Norton, 433 F.2d at 795-96; 167 USPQ at 545; see, *Miller*, Fraud on the PTO, 58 JPOS 271 (1976).

Garlock alleges fraud in Gore's representations that stretching PTFE tape at a rate greater than 10% per second was novel and that it produces a physical phenomenon. The district court found the evidence insufficient to establish that Gore had a specific intent to defraud the PTO. No basis exists for our overturning that finding. Accordingly, we agree with the district court that Garlock has failed to sustain its heavy burden of proving, by clear and convincing evidence, sufficient facts from which fraudulent intent can be inferred.

Garlock points to a September 4, 1975, Gore affidavit filed in the PTO that stated:

2. Prior to my invention disclosed in the captioned patent application, during production of expanded PTFE products by W. L. Gore & Associates, Inc., the rate of stretching was neither measured nor controlled and to my knowledge did not involve stretching of unsintered PTFE at a rate exceeding about 10% per second. (emphasis in original)

No finding of the district court and no evidence of record establishes that that state-

ment was made in reckless disregard of facts from which an intent to defraud may be inferred.

The district court's finding in 1982 that the 401 machine inherently stretched tape at some time in 1969 at a rate more than 10% per second, does not establish that Dr. Gore was aware of that fact in 1975, nor does it make untrue his statement that to his knowledge that had not been the rate of stretch employed. Nor does the district court's finding conflict with Dr. Gore's statement that the rate of stretching was neither measured nor controlled in the Gore shop before his invention of the claimed process as a whole.

Nor does the evidence of isolated statements support Garlock's contention that Dr. Gore attempted to convince the PTO that a physical phenomenon always existed in which stretching at a rate greater than 10% per second always produced a matrix tensile strength greater than 7300 psi. On the contrary, Dr. Gore set forth in his specification examples indicating that some samples broke, ruptured, or disintegrated.

(3) Attorney's Fees

The district court did not abuse its discretion in denying Garlock its request for attorney fees.

Infringement

[38] Where, as here, an appellate court reverses a holding of invalidity, and remand is ordered for trial of the factual issue of infringement, an inefficient use of judicial resources results if the second judgment is appealed. The better practice would therefore be for the district court to decide both the validity and infringement issues when both are contested at the trial, enabling the conduct of a single appeal and disposition of the entire case in a single appellate opinion.

Resolution of the infringement issue at trial may also overlap with resolution of the validity issue, where, for example, the claimed invention was or was not copied by the validity challenger, or the challenger substituted the claimed invention for freely available prior art processes or products, *Eibel*, supra, 261 U.S. at 56, or an assertion of nonenablement may conflict with the ease with which the accused infringer may be shown to have practiced the invention as taught in the patent. *Eibel Process Co. v. Minnesota & Ontario Paper Co.*, 261 U.S. 45, 61 (1923).

[39] The district court having declined to decide the infringement issue, Gore suggests that the record here is sufficient to warrant

our deciding it now. With reluctance in view of the length and bitter nature of the present litigation, we decline the suggestion. In so doing, we imply nothing of our view on the issue. Nor do we intend any implication that the district court could not itself determine the infringement issue on the present record. Infringement of particular claims of two patents was asserted. None of those claims has been finally held invalid. Assuming their continued assertion, infringement must be decided with respect to each asserted claim as a separate entity. *Altoona, supra*, 294 U.S. at 487. Those factual determinations should be made in the first instance by the district court.

Decision

The holdings of invalidity of claim 1 of the '566 patent under §102(a) and of claim 17 of the '566 patent under §103, the determination that Gore did not commit fraud on the PTO, and the denial of attorney fees, are affirmed; the holdings that all claims of the '566 patent are invalid under §102(b), that claims 3 and 19 of the '566 patent are invalid under §103, and that all claims of the '566 patent are invalid under §112, are reversed. The holdings that claims 1, 9, 12, 14, 18, 35, 36, 43, 67, and 77 of the '390 patent are invalid under §§102 and 103, and that all claims of the '390 patent are invalid under §112, are reversed. The case is remanded for determination of the infringement issue.

Affirmed in part, reversed in part, and remanded.

Appendix

Claims of the '566 patent discussed at trial:

1. A process for the production of a porous article of manufacture of a polymer of tetrafluoroethylene which process comprises expanding a shaped article consisting essentially of highly crystalline poly (tetrafluoroethylene) made by a paste-forming extrusion technique, after removal of lubricant, by stretching said unsintered shaped article at a rate exceeding about 10% per second and maintaining said shaped article at a temperature between about 35°C. and the crystalline melt point of said tetrafluoroethylene polymer during said stretching.

3. The process of claim 1 in which the rate of stretch is about 100% per second.

17. The process of claim 1 in which the shaped article is expanded such that its final length in the direction of expansion is greater than about twice the original length.

19. The process of claim 17 in which said final length is greater than about five times the original length.

Claims of the '390 patent discussed at trial:

1. A porous material consisting essentially of highly crystalline polytetrafluoroethylene polymer, which material has a microstructure characterized by nodes interconnected by fibrils and has a matrix tensile strength in at least one direction above about 73,000 psi.

9. A porous material consisting essentially of polytetrafluoroethylene polymer, which material has a microstructure characterized by nodes interconnected by fibrils and has a matrix tensile strength in at least one direction above 9290 psi, which material has been heated to a temperature above the crystalline melt point of said polymer and has a crystallinity below about 95%.

12. A porous material in accordance with claim 9 which is in the form of a shaped article.

14. A product in accordance with claim 12 which is in the form of a film.

18. A product in accordance with claim 12 which is in the form of continuous filaments.

35. A laminated structure comprising (a) a first shaped article formed of a porous material made of a tetrafluoroethylene polymer, which material has a microstructure characterized by nodes interconnected by fibrils and has a matrix tensile strength in at least one direction above about 7,300 psi, and (b) a second shaped article bonded to said first shaped article.

36. The structure of claim 35 in which said first shaped article is formed of a porous material which has a matrix tensile strength in at least one direction of at least 9290 psi, and has a crystallinity below about 95%.

43. A porous material made of a tetrafluoroethylene polymer, which material has a microstructure characterized by nodes interconnected by fibrils, which material (a) has a matrix tensile strength in at least one direction above about 9290 psi, (b) has been heated to a temperature above 327°C. and has a crystallinity below about 95%, and (c) has a dielectric constant of 1.2-1.8.

67. An impregnated structure comprising

(a) a shaped article formed of a porous material made of a tetrafluoroethylene polymer which material has a microstructure characterized by nodes interconnected by fibrils and a matrix tensile strength in at least one direction above about 9290 psi, and

(b) a polymer impregnated within the pores of the said shaped article.

77. The structure of claim 35 in which the first shaped article is a sheet having pores that will pass a gas but will not pass liquid water.

Davis, Circuit Judge, concurring in the result in part and dissenting in part.

I concur in the result on (1) the validity of the '390 patent under §§ 102-103; (2) the validity of the '390 patent under § 112; (3) the invalidity of claims 1 and 17 of the '566 patent; (4) lack of fraud on the Patent and Trademark Office; and (5) denial of attorneys' fees. I disagree and dissent as to the validity of claims 3 and 19 of the '566 patent.

1. The process invention embodied in claim 1 of the '566 patent was known, through use of the 401 machine in the Gore shop, well before the "invention date" (claimed by Robert Gore, the inventor) of October 1969.¹ As such, the claimed invention was invalid on at least three grounds: (i) it was anticipated and therefore would have been obvious (under 35 U.S.C. § 103) at the time of the claimed invention date; (ii) the invention was "in public use" by the Gore shop (under 35 U.S.C. § 102(b)) more than one year prior to the patent application (i.e., prior to May 21, 1969); and (iii) the invention (made by Robert Gore) was known to and used "by others in this country" (35 U.S.C. § 102(a)) before the claimed invention date of October 1969, i.e. the invention was used by Wilbert Gore and others in the Gore shop before the October date.²

The critically important aspect of the invention of the '566 patent is the stretching of PTFE at a rate above 10% per second.³ Robert Gore testified that he conceived this invention no earlier than October 1969 (and we have the right to take him at his word),⁴ but the facts found by the District Court plainly show that the Gore shop was in fact practicing that invention considerably earlier.

¹ The 401 machine was used under the prior '915 patent (issued to Wilbert Gore) which contains no reference to the significance of the rate of stretch.

² Aside from the bases I discuss, I do not reach the other grounds asserted for invalidity of the '566 patent.

³ Before the PTO Robert Gore concededly referred to this as "critical" to his invention or as his "invention."

⁴ The District Court found that October 1969 was the earliest date Robert Gore asserts for his conception of the invention in the '566 patent.

The District Court found that in the 401 machine the distance between the stretch rollers controls the rate of stretch; a shorter distance results in a higher rate of stretch; for the process described in the '915 patent to be practiced with a rate of stretch below 10% per second, the distance between the stretch rollers would have to be greater than five feet; if the distance is less than four feet, the rate of stretch is greater than 10% per second; the machine drawings used to construct the 401 machine indicate that the distance between the stretch rollers was eight inches; a Gore employee testified that "I am reasonably sure that no effective [stretch] rolls in question would have been more than three feet simply because of the nature and size of the equipment" and that he did not remember any stretching more than three feet; another Gore employee testified that the distance between the rollers was "a maximum of 18 inches" (emphasis added); a document prepared by the same employee (an engineer) on June 10, 1969 reports that the stretch span was 8 inches; the 401 machine was the only stretching machine used by the Gore company; and the 401 machine was never substantially changed before October 1969. All this adds up to the fact that the 401 machine was at all relevant times operated with a stretch of less than four feet.⁵ There is no question that the machine was so operated before October 1969 (the District Court found that sales of tape made by the 401 machine were proposed in August 1969).

I can accept Robert Gore's affidavit (to the PTO) that there was no stretching in the Gore shop at a rate exceeding about 10% per second prior to "my invention disclosed in the captioned patent application" (emphasis added),⁶ only because that declaration was expressly qualified by the phrase "to my knowledge" (emphasis added). The District Court specifically found no specific intent by Robert Gore to defraud and, on this record, we

⁵ The Gores (Robert and Wilbert) testified at trial that the distance was five feet but there is no indication that the trial court (which did not cite this testimony but did cite the opposing evidence) credited the Gores' testimony.

⁶ The factor of the rate of stretching was of direct interest to the examiner during the prosecution of the '566 patent. In response to the examiner's express request for a declaration that the Gore firm's production of stretched PTFE tape, prior to Robert Gore's invention asserted here, did not involve stretching of unsintered PTFE at a rate exceeding about 10% per second, Robert Gore filed an affidavit in the PTO specifically stating that "to my knowledge" (emphasis added) the 401 machine did not involve stretching at a rate exceeding about 10% per second.

cannot properly overturn that finding. But the absence of personal intent to defraud does not mean or say that, whether Robert Gore realized it or not, the 401 machine was not actually operating, well before October 1969, to stretch unsintered PTFE at a rate exceeding about 10% per second. Cf. *O'Brien v. Westinghouse Electric Corp.*, 293 F.2d 1, 10 (3rd Cir. 1961). It seems impossible to me to reconcile Robert Gore's insistence on two facts--that (i) he invented the process in October 1969 and (ii) he had no knowledge prior to October 1969 of stretching PTFE at the critical rate--with the solid facts in the record as to the prior operation of the 401 machine, except on the view that Robert Gore did not realize that he and others in the Gore shop had made his invention previously.

2. It follows that in October 1969 the invention of '566 would have been obvious under §103 to Robert Gore because the prior practice of the 401 machine constituted prior art. Even if this was not prior art technically within §102, that statutory provision "is not the *only* source of prior art." In *re Fout*, 675 F.2d 297, 300 (CCPA 1982, emphasis in original). The 401 machine was practiced under the '915 patent (issued to Wilbert Gore) and, whether or not Robert Gore subjectively realized what was happening, he and others in the Gore shop were practicing the invention later embodied in the '566 patent. That was prior art at least as to Robert Gore. *Id.* at 300-01.⁷

3. If it be thought necessary to invoke §102 directly, in order to show anticipation, the record contains proof that the 401 machine was designed, constructed and used (just as described supra) in November and December 1968 and the early months of 1969--more than one year prior to the '566 patent application of May 21, 1970. See *Jt. App. E 1199-E 1200*. Section 102(b) therefore applies. Although commercial production was apparently not actively sought until June 1969, the practicing of the 401 machine prior to May 21, 1969 was "a public use" because the Gore company made "use of the device *** in the factory in the regular course of business." *Connecticut Valley Enterprises, Inc. v. United States*, 348 F.2d 949, 952, 146 USPQ 404, 406 (Ct. Cl. 1965).

⁷ The District Court has found that there are no differences between claim 1 of the '566 patent and the processes previously used by the Gore firm to produce paste-extruded unsintered PTFE.

4. Also, §102(a)⁸ applies here because Robert Gore was the inventor in the '566 patent and Wilbert Gore and others in the Gore shop were using the 401 machine before October 1969. Wilbert Gore (the inventor in the '915 patent under which the 401 machine was made and used) and the other employees are "others" within §102(a)--they are not the same as Robert Gore who claimed to be inventor of the process that ripened into the '566 patent.⁹ See also §102(f), which would bar Robert Gore if he did not himself invent the subject matter of the '566 patent.¹⁰

5. The majority sustains the validity of claims 3 and 19 of the '566 patent (the claims also involved in appellant's suit for infringement) which are dependent on invalid claim 1. Because of the invalidity of claim 1 the only possible novelty in claim 3 would be the requirement that the rate of stretch would be about 100% per second, and the possible novelty of claim 19 would be that the final length would be greater than about five times the original length. My position is that both of these added elements, if novel, would have been obvious to persons of ordinary skill in the art.

The defect in the majority's analysis is that it neglects the cardinal fact that the prior art included the 401 machine (discussed supra), not merely the earlier patents assessed in the majority opinion. The 401 machine directly involved PTFE itself, not conventional thermoplastic polymers. That machine also directly involved rapid stretching of PTFE at a rate markedly exceeding 10%. With this prior art of the 401 machine before him, an ordinary person skilled in the art would maximize stretch rate, if only to improve the machine's production rate. Cf. *In re Dwyer, Jewell, Johnson, McGrath, & Rubin*, 317 F.2d 203, 207, 137 USPQ 540 (CCPA 1963). Moreover, the very existence and operation of the 401 machine, which stretched PTFE rapidly without breaking, suggests to the skilled person the probability of stretching at even higher rates. Certainly, in the light of the 401 machine, skilled workers would see in at least

⁸ An invention is anticipated if it "was known or used by others in this country *** before the invention thereof by the applicant for patent" (emphasis added).

⁹ It is undisputed that it was Wilbert Gore who initiated the project for the 401 machine and watched over it.

¹⁰ The majority's discussion of "secondary considerations," though it is relevant to other aspects of this case, is irrelevant to the issue of anticipation raised by the 401 machine, and hardly persuasive as to the issues of obviousness based on or with respect to the 401 machine.

the prior Markwood, Nash, and Scarlett patents (teaching extensive and rapid stretching of non-PTFE thermoplastics) the suggestion that the method of the 401 machine could also be used for comparable rapid and extensive stretching of PTFE.

6. In sum, I cannot escape the conclusion that--although there was no fraud proved--if the true facts as to the 401 machine had been made known to the PTO (as it requested), the involved claims of the '566 patent should (and probably would) not have been accepted.

Court of Appeals, Second Circuit

Harper & Row, Publishers, Inc. et al.
v. Nation Enterprises et al.

Nos. 83-7277 and 83-7327

Decided Nov. 17, 1983

COPYRIGHTS

1. In general (§24.01)

Copyright Act sets out test for preemption of state statutory or common law that may conflict with federal policies embodied in Act.

2. Matter copyrightable — Classes in statute (§24.303)

Work of authorship in which rights are claimed must fall within "subject matter of copyright" as defined in Copyright Act Sections 102 and 103; Act embraces "works of authorship," including "literary works," as within its subject matter.

3. Matter copyrightable — In general (§24.301)

Fact that portions of memoirs may consist of uncopyrightable material does not take work as whole outside subject matter protected by Copyright Act; were this not so, states would be free to expand perimeters of copyright protection to their own liking, on theory that preemption would be no bar to state protection of material not meeting federal statutory standards; that interpretation would run directly afoul of one of Act's central purposes, to avoid development of any vague borderline areas between state and federal protection.

4. In general (§24.01)

Copyright Act requires that state law create legal or equitable rights that are equiva-

alent to any of exclusive rights within general scope of copyright as specified in Section 106 if it is to be preempted; these include rights to reproduce copyrighted work in copies, and to prepare derivative works based upon copyrighted work; when right defined by state law may be abridged by act that, in and of itself, would infringe one of exclusive rights, state law in question must be deemed preempted; conversely, when state law violation is predicated upon act incorporating elements beyond mere reproduction or the like, rights involved are not equivalent, and preemption will not occur.

5. Rights embraced in copyright (§24.50)

There is no qualitative difference between right of author and his licensed publishers to exercise and enjoy benefit of pre-book publication serialization rights, and exclusive right under Copyright Act of preparing derivative works based on copyrighted work; enjoyment of benefits from derivative use is so intimately bound up with right itself it could not possibly be deemed separate element.

6. In general (§24.01)

Fact that plaintiffs pleaded additional elements of awareness and intentional interference, not part of copyright infringement claim, in support of state law claim, goes merely to scope of right; it does not establish qualitatively different conduct on part of infringing party, nor fundamental non-equivalence between state and federal rights implicated.

7. Matter copyrightable — In general (§24.301)

Copyright Act protects only original works of authors; it grants rights not in ideas or facts, but in expression; one reasonable interpretation of word "discovery" in statute is "fact"; for example, historian who learns in his research that certain event has occurred has discovered fact; copyright does not preclude others from using ideas or information revealed by author's work; Act is thus able to protect authors without impeding public's access to information that gives meaning to our society's highly valued freedom of expression; neither news events, historical facts, nor facts of biographical nature are deserving of Act's protection; listing of names, nouns, or information is indisputably copyrightable as compilation, but preexisting facts contained in those lists are not protected.

8. Matter copyrightable — In general (§24.301)

Distinction between fact and expression is not always easy to draw; author's originality

tion Ball may result in irreparable harm for purposes of entitlement to a Preliminary Injunction. The potential harm to the apparent infringer, the Defendants, does not weigh against the granting of injunctive relief. Further, the public interest is served by a Preliminary Injunction that prevents consumer confusion. By promoting a concert in Ohio using Moondog Coronation Ball, the Defendants have used Plaintiff's service mark without Plaintiff's permission in a way that is infringing Plaintiff's rights in the service mark. Therefore, OmniAmerica is entitled to a Preliminary Injunction.

IT IS THEREFORE ORDERED that the Defendants Street Gold Records, Ltd. dba Canterbury Productions/Farag Music BMI, the Moondog Coronation Ball Corp., and Independent Group Limited Partnership, their agents, and any other persons associated with or acting in concert with them, including but not limited to, Henry Farag and Canterbury Productions, Inc., be and hereby are restrained and enjoined from using the service mark "Moondog Coronation Ball" or any similar service mark in connection with any concert or other event. Use of a Mark that includes the words "Moondog" and "Coronation" in connection with a concert or other event will be considered to be use of a similar mark.

Specifically, Defendants, their agents, and any other persons associated with or acting in concert with them, including, but not limited to Mr. Henry Farag, Mr. Omar Farag, and Canterbury Productions, Inc. are enjoined from:

- 1) selling, issuing, or releasing any tickets bearing the service mark Moondog Coronation Ball or any similar mark;
- 2) issuing any written or oral promotion of the concert scheduled for March 23, 1996, or any other concert or event produced by Defendants, using the service mark Moondog Coronation Ball or any similar service mark;
- 3) making any representations that the concert scheduled for March 23, 1996, or any other concert or event produced by Defendants, is the Moondog Coronation Ball.

CONCLUSION

Based upon the forgoing reasons, Plaintiff, OmniAmerica's Motion for a Preliminary Injunction is GRANTED. All matters pertaining to damages, and any issues relating to the expiration of the service mark that expires on March 10, 1996, will be addressed at the Permanent Injunction Hearing which

will be held at a later date to be determined by this Court.

IT IS SO ORDERED.

U.S. Court of Appeals Federal Circuit

Sensonics Inc. v. Aerosonic Corp.

Nos. 95-1058, -1062, -1098

Decided April 24, 1996

PATENTS

1. Patentability/Validity — Obviousness — Combining references (§115.0905)

Claimed vibrator for aircraft instruments is not obvious in view of prior art references considered alone or in combination, since there is no teaching or suggestion whereby person of ordinary skill in art would have been led to select particular mechanical and electrical structures and concepts and combine them as did inventor, and since drawing on hindsight knowledge of patented invention, when prior art does not contain or suggest that knowledge, is improper use of invention as template for its own reconstruction.

2. Infringement — Defenses — Fraud or unclean hands (§120.1111)

Failure to disclose inventor's prior patent during prosecution of patent in suit did not constitute inequitable conduct, since defendant's failure to mention prior patent in its request for re-examination of patent in suit weighs heavily against its contention that prior patent was material prior art, and since there is no evidence of culpable intent.

3. Infringement — Willful (§120.16)

Federal district court did not clearly err by concluding that defendants did not willfully infringe vibrator patent in suit, even though opinion of defendants' counsel does not mention defendants' copying and other objective indicia of unobviousness, and infringement continued even after validity of patent was confirmed on re-examination, since issue of willfulness raises questions of credibility as well as weight, and findings thereon are not readily reversed, and since infringement occurred four months prior to patent's expiration.

REMEDIES**4. Monetary — Damages — Patents — Lost profits (§510.0507.05)**

Infringement defendant's failure to retain production records during litigation gives rise to strong inference that such records would have been unfavorable to defendant, since it is not necessary to establish bad faith in order to draw adverse inference from "purposeful" action, and since it is appropriate that doubt be resolved against defendant in view of clear duty to keep and preserve records of acts for which infringement had been charged; federal district court's determination that 7,347 infringing units had been produced by defendant, based on extrapolation from production records available for final six months of patent's term, represents best available reconstruction of infringing activity, but court's reduction of extrapolated production by 33 percent to account for device repair or inefficiency in production is not supported by evidence.

5. Monetary — Damages — Patents — Increased damages (§510.0507.07)

Federal district court did not abuse its discretion by declining to award enhanced damages for patent infringement, since enhanced damages are punitive rather than compensatory, and depend on showing of willful infringement or other indicium of bad faith warranting punitive damages, and since court's finding that infringement was not willful was not clear error.

6. Monetary — Damages — Prejudgment interest (§510.0511)

Prejudgment interest in patent cases is withheld only under exceptional circumstances, and denial of such award based on calculation difficulties alone is error; prejudgment interest award is therefore warranted in present patent action in which there is no circumstance that would make such award unfair or inappropriate.

7. Monetary — Attorneys' fees; costs — Patents — Exceptional case (§510.0905.03)

Bad faith and willful infringement are not only criteria whereby case may be deemed "exceptional," since litigation misconduct and unprofessional behavior are relevant to award of attorneys' fees; remand of present case for determination of whether there was bad faith or vexatious behavior is therefore warranted, even though federal district court did not err in concluding that defendants did not willfully infringe.

PATENTS**8. Infringement — Inducement (§120.15)****REMEDIES****Monetary — Damages — Personal liability of corporate officials (§510.0513)**

Federal district court properly concluded that individual defendant who was founder, owner, president, chief executive officer, and chief of engineering of infringing corporation is liable for inducement to infringe, and is jointly and severally liable for amount of judgment, since weight of evidence is strongly contrary to defendant's testimony that he was without authority to control or discontinue production of infringing device after becoming aware of plaintiff's patent rights, and since court therefore did not clearly err in determining that testimony was not credible.

Particular patents — Electrical — Tapping device

3,863,114, DeMayo, tapping device for generating periodic mechanical impulses, ruling that patent is enforceable, not invalid, and infringed is affirmed.

Appeal from the U.S. District Court for the Middle District of Florida, Merhige, J.

Action by Sensonics Inc. against Aerosonic Corp. and Herbert J. Frank for patent infringement. From ruling that patent claims are enforceable, not invalid, and infringed, and that defendant Herbert J. Frank is personally liable for inducing infringement, defendants appeal. Plaintiff cross-appeals measure of damages and denial of enhanced damages and attorneys' fees. Affirmed in part, modified and reversed in part, and remanded.

Daniel P. Burke, of Galgano & Burke, Hauppauge, N.Y., for plaintiff/cross-appellant.

Robert E. Greenstien, of Honigman, Miller, Schwartz & Cohn, West Palm Beach, Fla.; Anne E. Brookes, John T. Klug, Louis K. Bonham, and John G. Flaim, of Honigman, Miller, Schwartz & Cohn, Houston, Texas; Robert W. Boos and Kevin M. Gilhool, of Honigman, Miller, Schwartz & Cohn, Tampa, Fla., for defendant-appellant Aerosonic Corp.

Sybil Meloy, Lisa S. Mankofsky, and Patricia D. Granados, of Foley & Lardner, Washington, D.C., for defendant-appellant Herbert J. Frank.

Before Newman, circuit judge, Bennett, senior circuit judge, and Bryson, circuit judge.

Newman, J.

This consolidated appeal and cross-appeal concern United States Patent No. 3,863,114 (the '114 patent) owned by Sensonics, Inc. The defendants, Aerosonic Corp. and Herbert J. Frank, each appeals certain aspects of the judgment of the United States District Court for the Middle District of Florida.¹ Aerosonic appeals the district court's ruling that the '114 patent is valid and enforceable, and also appeals the ruling of infringement as to some of the patent claims but not as to others. Mr. Frank appeals the ruling that he is personally liable for inducement to infringe the Sensonics patent. Sensonics cross-appeals the measure of damages, and the court's denial of enhanced damages and attorney fees.

THE PATENTED INVENTION

The '114 patent is for a "Tapping Device for Generating Periodic Mechanical Pulses," inventor John F. DeMayo. Mr. DeMayo is a founder and officer of Sensonics. The tapping device, also called a "vibrator," is used primarily with aircraft instruments having moving indicators. Mechanical pulses, that is, taps, gently vibrate the moving parts in order to free them of the effects of static friction, permitting the indicator to move freely and thus with greater accuracy and reliability. Such devices require accurate and reliable operation for extended periods of time and over wide temperature and voltage ranges. They require careful control of the strength of the vibration pulses in order to avoid causing errors in or requiring recalibration of the aircraft instrument.

The invention claimed in the '114 patent is an electromagnetic vibrator that is easier to manufacture, more accurate, easier to adjust, and less expensive than prior devices. Its structure of a unitary base with integrally formed anvil and armature support eliminated the welding and soldering steps of earlier devices, and also assured a true and consistent path for the magnetic flux. Another advantageous structural component is the adjustment element for the strength of the vibration pulses, in the form of a screw which extends through the armature to the magnetic core. The head of the screw provides the stop for the moving armature, and thus adjustment of the screw enables ready adjust-

ment of the mechanical pulses without removing the device from its casing, a disadvantage of prior vibrators.

It was not disputed that Aerosonic copied the Sensonics device in complete detail, and replaced the vibrating-reed design of the vibrator that Aerosonic was then making commercially. Mr. Frank and other witnesses testified that the vibrating-reed design was hard to manufacture, had an unacceptably high failure rate after installation, and was deficient in that it did not allow adjustment of the strength of the mechanical pulses. The superiority of the Sensonics device in accuracy, reliability, and cost, was undisputed.

PATENT VALIDITY

Aerosonic raised the defense of patent invalidity based on obviousness in terms of 35 U.S.C. § 103. The principal prior art at trial was an earlier invention of Mr. DeMayo, described in United States Patent No. 3,507,339 (the '339 patent). This patent was not cited as a reference during prosecution of the application that led to the '114 patent.

Mr. DeMayo testified that the '339 patent represented an earlier effort to make an improved mechanical vibrator. There was evidence that the '339 design had some advantages over prior devices, but that its shortcomings included manufacturing complexity, increased size, multiple components, difficulty of assembly, difficulty of adjustment, and too high a failure rate. Mr. DeMayo testified that he continued to work to solve these problems, and that after several additional years of effort he succeeded in doing so, with the vibrator that became the subject of the '114 patent. Although the '114 design and the '339 design have several similarities, there was evidence that the changes embodied in the '114 device achieved the simplicity and efficiency of manufacture, easy and accurate adjustment, compactness, quietness in operation, and reliability, that were inadequate in the '339 device.

The '339 device has a screw extending through the armature to the magnetic core. This screw is soldered into place in order to provide sufficient contact within the device to ensure magnetic flux, and is not usable to adjust the strength of the pulses. Although at trial Aerosonic argued that it was obvious to make the design change of an adjustable screw, the district court observed that this element of the '114 invention provided significant advantages and remedied deficiencies of prior devices. The pulse strength for the '339 device was only adjustable from below, and thus was not readily adjusted

¹ *Sensonics, Inc. v. Aerosonic Corp.*, Nos. 90-84-T-23A and 93-724-T-23A (M.D. Fla. Oct. 11 and Nov. 4, 1994).

after installation. In contrast, the '114 device could be readily adjusted not only during manufacture but also after assembly and after installation in the aircraft instrument. Although Aerosonic points to the simplicity of this adjustment mechanism, simplicity does not establish obviousness; indeed, simplicity may represent a significant and unobvious advance over the complexity of prior devices.

The district court referred to the factual underpinnings of the determination of obviousness as set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966). Applying these criteria, the court discussed the testimony of Aerosonic's expert witness concerning the prior art. In addition to the '339 patent, the references relied on by Aerosonic were two patents on "telegraph-sounders" that were designed to make noise, a patent on a magnetically operated switch designed to absorb any shock created by contact of its armature and magnetic core, a patent on a relay for telephone lines to control secondary signals, and a patent for an automobile voltage regulator.

[1] The district court concluded that "[c]onsidered in their entirety, the references discussed by defendants' expert do not, in the court's view, lead one of ordinary skill in the art to the invention in suit." We agree that the references, alone or in combination, do not make obvious the '114 invention. There is no teaching or suggestion whereby a person of ordinary skill would have been led to select these mechanical and electrical structures and concepts and combine them as did DeMayo in the '114 invention. To draw on hindsight knowledge of the patented invention, when the prior art does not contain or suggest that knowledge, is to use the invention as a template for its own reconstruction — an illogical and inappropriate process by which to determine patentability. *W.L. Gore & Assoc. v. Garlock, Inc.*, 721 F.2d 1540, 1553, 220 USPQ 303, 312-13 (Fed. Cir. 1983). The invention must be viewed not after the blueprint has been drawn by the inventor, but as it would have been perceived in the state of the art that existed at the time the invention was made. *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1138, 227 USPQ 543, 547 (Fed. Cir. 1985).

The DeMayo '114 device was placed in commercial production by Sensonics. Aerosonic purchased fifty of the Sensonics vibrators from Budd Electronics Corp. An Aerosonic engineer testified that he was instructed by Mr. Frank to copy every detail of the Sensonics device, mentioning the number of turns of wire in the electromagnet and

the wire thickness, the tension of the spring, the posts supporting the armature, the unitary construction, the adjustable screw, etc. Mr. Frank and other employees of Aerosonic testified that there were no acceptable substitutes in the industry for the DeMayo '114 vibrator design.

Patent invalidity must be proved by clear and convincing evidence. The differences from the prior art that were shown at trial, the inadequacies of prior vibrators including DeMayo's earlier '339 design, and the technologic advantages and commercial success of the '114 invention, well support the district court's conclusion that invalidity based on obviousness had not been proved. The decision that the patent is valid is affirmed.

PATENT ENFORCEABILITY

Aerosonic charged Sensonics with inequitable conduct before the Patent and Trademark Office because Sensonics did not bring to the attention of the patent examiner the DeMayo '339 patent. The district court held that the intent element of inequitable conduct had not been shown, and referred to the evidence presented at trial of Sensonics' good faith. The court also observed that Aerosonic's own patent counsel did not initially notice the relevance of the '339 patent, and that the '339 patent was not cited by Aerosonic in its reexamination request which was made during the litigation, and for which the litigation was stayed.

The district court found that Mr. DeMayo, who testified at trial, was not aware of a need to direct the examiner to the '339 patent. Mr. DeMayo also testified that he did not believe that the '339 patent was relevant to the '114 invention due to the differences and significant drawbacks in the '339 design; this testimony was supported by other evidence of the differences and drawbacks of the '339 and other prior devices.

[2] Aerosonic presses the argument that Sensonics did not seek reexamination of the '114 patent in light of the '339 patent until after expiration of the '114 patent. The '114 patent expired during the litigation. The district court observed that Aerosonic had earlier requested reexamination of the '114 patent, but that Aerosonic did not mention the '339 patent in its reexamination papers. Indeed, Aerosonic's omission of the '339 patent from its reexamination request weighs heavily against its argument that the '339 patent was material prior art.

The burden of proof of inequitable conduct was upon Aerosonic. The factual predicates of both (1) a withholding of material

prior art and (2) the intent thereby to deceive or mislead the patent examiner into allowing the claims, must be shown by clear and convincing evidence. *Kingsdown Medical Consultants, Ltd. v. Hollister*, 863 F.2d 867, 872, 9 USPQ2d 1384, 1389 (Fed. Cir. 1988), cert. denied, 490 U.S. 1067 (1989). There was no evidence of culpable intent. The totality of the evidence, including the evidence of good faith, well supports the district court's finding that intent to deceive or mislead the examiner was not shown.

Absent reversible error in the district court's findings and conclusion, we affirm the decision that there was not inequitable conduct before the patent office and that the '114 patent is enforceable.

WILLFUL INFRINGEMENT

Aerosonic stipulated that it infringed claims 2 and 7. The district court found that Aerosonic also infringed claims 3, 8 and 11. Aerosonic appeals this latter finding, advising that we need not reach claims 3, 8, and 11 should we sustain the validity of claims 2 or 7. Thus the only infringement issue is Sensonics's cross-appeal of the district court's finding that Aerosonic's infringement was not willful.

Sensonics states that the court clearly erred in failing to find that the infringement was willful, referring to Aerosonic's deliberate and meticulous copying of the Sensonics device, and Aerosonic's delay of eight months before consulting patent counsel after it received written notice of infringement, as evidence that Aerosonic willfully disregarded or did not intend to respect the law. The devices that Aerosonic purchased from Budd Electronics and copied were all labelled with Sensonics' name. Sensonics states that the opinion of counsel that Aerosonic produced at trial was "protective" and was not a complete analysis, and that Aerosonic's continuing infringement after actual notice of Sensonics' patent was with knowledge and disregard of Sensonics' legal rights. Indeed, the opinion of counsel makes no mention of Aerosonic's copying and other objective indicia of unobviousness, although precedent requires that these factors be considered. See *Stratoflex v. Aeroquip Corp.*, 713 F.2d 1530, 1539, 216 USPQ 871, 879 (Fed. Cir. 1983) (evidence of objective considerations must always be taken into account).

[3] Although the opinion of Aerosonic's counsel is flawed, the issue of willfulness raises questions of credibility as well as weight, and findings thereon are not readily

reversed. See *King Instrument Corp. v. Otari Corp.*, 767 F.2d 853, 867, 226 USPQ 402, 412 (Fed. Cir. 1985) (giving due deference to the trier's right to determine credibility and weight). The district court found that Aerosonic timely retained patent counsel and reasonably relied on counsel's opinion. Although it is relevant that the infringement was continued even after the '114 patent was confirmed on reexamination, this occurred four months before patent expiration, and Sensonics does not argue that this event of itself signals willful infringement. On the whole we do not discern clear error in the district court's findings and conclusion on the issue of willful infringement.

DAMAGES

Sensonics appeals the district court's measure of damages, on the ground that the district court incorrectly assessed the number of infringing devices made by Aerosonic.

The criteria for lost profits damages that are summarized in *Panduit Corp. v. Stahl Bros. Fiber Works, Inc.*, 575 F.2d 1152, 197 USPQ 726 (6th Cir. 1978), were applied by the district court. The court found that Sensonics had proved (1) demand for the patented product, (2) Sensonics' ability to meet that demand, (3) the absence of acceptable non-infringing substitutes, and (4) the amount of lost profits per unit. The principal issue at trial was not any of these criteria, but the total number of devices that were made by Aerosonic during the period between actual notice of infringement on September 14, 1989 and the expiration of the '114 patent on January 28, 1992.

This issue arose because Aerosonic had apparently destroyed its manufacturing records after this litigation began. No manufacturing records were available for the relevant period except for a handwritten log book of serial numbers that covered the final six months preceding the expiration of the patent. This log commenced with number 21,267 in July 1991, after this suit had been pending for a year. It was the only remaining evidence of the number of devices manufactured. Aerosonic argues that the burden of proof of damages is upon the patentee, and that since the number of devices manufactured could not be proved, the burden could not be met.

However, if actual damages can not be ascertained with precision because the evidence available from the infringer is inadequate, damages may be estimated on the best available evidence, taking cognizance of the reason for the inadequacy of proof and

resolving doubt against the infringer. See *Westinghouse Elec. & Mfg. Co.*, 225 U.S. 604, 620 (1912) (infringer bears the risk when precise calculation is not possible); *Kori Corp. v. Wilco Marsh Buggies and Draglines, Inc.*, 761 F.2d 649, 655, 225 USPQ 985, 989 (Fed. Cir.) ("Fundamental principles of justice require us to throw any risk of uncertainty upon the wrongdoer rather than upon the injured party.") (citing *Story Parchment Co. v. Paterson Parchment Co.*, 282 U.S. 555, 563 (1931)), cert. denied, 474 U.S. 902 (1985).

When the calculation of damages is impeded by incomplete records of the infringer, adverse inferences are appropriately drawn. See *Lam, Inc. v. Johns-Manville Corp.*, 718 F.2d 1056, 1065, 219 USPQ 670, 675 (Fed. Cir. 1983) (any adverse consequences rest upon the infringer when inability to ascertain lost profits is due to the infringer's failure to keep accurate or complete records). When manufacturing records were destroyed after the litigation commenced, strong inferences adverse to the infringer may be drawn. *Beatrice Foods Co. v. New England Printing and Lithographing Co.*, 899 F.2d 1171, 1176, 14 USPQ2d 1020, 1024 (Fed. Cir. 1990).

The district court found that the final six months' log was the only evidence of the number of devices manufactured. The log listed 1,037 vibrators to which serial numbers were given during the final six months of the life of the '114 patent. From this number the district court extrapolated back, assuming an equal rate of production over the previous three years, to a total of 7,347 units manufactured between the date notice of infringement was given to Aerosonic and the date of patent expiration. See *Beatrice Foods*, 899 F.2d at 1176, 14 USPQ2d at 1024 (damages appropriately measured by reconstruction when infringer had destroyed its invoices). Sensonics states that this extrapolation gives an unrealistically low figure because Aerosonic would reasonably be expected to have cut back on infringing production for the last few months of patent life, especially because this litigation was ongoing.

[4] Sensonics states that Aerosonic's failure to retain production records during the litigation period requires that strong adverse inferences be drawn. We agree that this circumstance gives rise to a strong inference that the records would have been unfavorable to Aerosonic. *Lam v. Johns-Manville*, 718 F.2d at 1065, 219 USPQ at 675. Indeed, as the court discussed in *Nation-Wide Check Corp. v. Forest Hills Distribs., Inc.*, 692 F.2d 214, 218 (1st Cir. 1982), it is not

necessary to establish bad faith in order to draw an adverse inference from "purposeful" action:

The adverse inference is based on two rationales, one evidentiary and one not. The evidentiary rationale is nothing more than the common sense observation that a party who has notice that a document is relevant to litigation and who proceeds to destroy the document is more likely to have been threatened by the document than is a party in the same position who does not destroy the document. . . .

The other rationale for the inference has to do with its prophylactic and punitive effects. Allowing the trier of fact to draw the inference presumably deters parties from destroying relevant evidence before it can be introduced at trial.

citing 2 *Wigmore on Evidence* § 291, at 228 (Chadbourn rev. 1979).

Aerosonic had the clear duty of keeping and preserving records of the acts for which infringement had been charged, and it is appropriate that doubt be resolved against Aerosonic. Although Aerosonic's actions warrant adverse inferences, Sensonics does not suggest an alternative to the extrapolation method adopted by the district court. Thus the district court's extrapolation represents the best available reconstruction of the infringing activity, and is sustained.

The district court then reduced the extrapolated production of 7,347 units by 33% "in order to account for any duplication resulting from device repair or inefficiency in production of the vibrators." Sensonics states that this reduction is unsupported by evidence, and contrary to the great weight of the evidence. We must agree. There was no evidence that device repair or production inefficiency was reflected in the log showing the serial number that was applied when the vibrator was ready for shipment or installation. Mr. Frank, who was the chief executive officer of Aerosonic during this period, testified that: "The serial number is put on the vibrator just before it is shipped, or before we put it into an indicator." On this procedure, any device repair or inefficiency in production would not be reflected in the serial number.

The Aerosonic log that was produced included repairs. It was the only record of repairs that was produced, and showed a repair rate of less than 0.4%, without a change of serial number for the repaired unit. Aerosonic did not establish that 33% or any other number of vibrators bore multiple serial numbers or were given new serial numbers after they were returned for repair. Further, if evidentiary imprecision is due to

inadequacy of the infringer's records, uncertainty is resolved against the wrongdoer. *Kori v. Wilco*, 761 F.2d at 655, 225 USPQ at 989; *Lam v. Johns-Manville*, 718 F.2d at 1065, 219 USPQ at 675.

Aerosonic states that damages are measured not by the number of devices manufactured but by the number of devices sold before patent expiration, arguing that there is no record evidence of when the devices listed on the serial number log were sold, but that they would have been sold mostly after patent expiration. The statement of law is incorrect. The patent statute grants the patentee the right to exclude others from making, using, or selling the patented subject matter. 35 U.S.C. § 271. Any of these activities during the patent term is an infringement of the patent right.

In the absence of any evidence that a significant number of the units to which a serial number was given were not separate manufactures, the district court's reduction of the total of 7,347 is clearly in error, and is reversed. Damages shall be paid on 7,347 units. The district court's decision is modified accordingly.

ENHANCEMENT OF DAMAGES

Sensonics states that the district court abused its discretion in declining to enhance damages in accordance with 35 U.S.C. § 284 ("the court may increase the damages up to three times the amount found or assessed"). The district court's decision with respect to the enhancement of damages will be sustained unless it was based on an incorrect conclusion of law, clearly erroneous findings of fact, or a clear error of judgment. *National Presto Industries, Inc. v. The West Bend Co.*, 76 F.3d 1185, 1193, 37 USPQ2d 1685, 1691 (Fed. Cir. 1996).

[5] Section 284 does not state the circumstances in which damages may be enhanced by the court. In *Yarway Corp. v. Eur-Control USA, Inc.*, 775 F.2d 268, 277, 227 USPQ 352, 358 (Fed. Cir. 1985) the court explained that "enhancement of damages must be premised on willful infringement or bad faith." See *Shatterproof Glass Corp. v. Libbey-Owens Ford Co.*, 758 F.2d 613, 628, 225 USPQ 634, 644 (Fed. Cir.), cert. dismissed, 474 U.S. 976 (1985) (absent willful infringement, enhanced damages are usually not warranted). As elaborated in *Beatrice Foods Co. v. New England Printing and Lithographing Co.*, 923 F.2d 1576, 1580, 17 USPQ2d 1553, 1556 (1991), enhanced damages are punitive, not compensatory. Enhancement is not a substitute for perceived

inadequacies in the calculation of actual damages, but depends on a showing of willful infringement or other indicium of bad faith warranting punitive damages.

The district court declined to enhance damages. Since we have affirmed the finding that the infringement was not willful, we conclude that the district court acted within its discretion in declining to enhance damages pursuant to § 284.

PREJUDGMENT INTEREST

[6] The district court denied prejudgment interest, referring to the difficulty of its calculation. It was established in *General Motors Corp. v. Devex Corp.*, 461 U.S. 648, 217 USPQ 1185 (1983) that prejudgment interest is the rule, not the exception. The Supreme Court explained that the denial of prejudgment interest simply creates an incentive to prolong litigation, and that prejudgment interest in patent cases is withheld only under exceptional circumstances. 461 U.S. at 656-57, 217 USPQ at 1189. In *Lumus Industries, Inc. v. D.M. & E. Corp.*, 862 F.2d 267, 274-75, 8 USPQ2d 1983, 1988 (Fed. Cir. 1988) the court held that "[t]o deny prejudgment interest based on calculation difficulties alone would be error."

We have been directed to no circumstance that would make it unfair or inappropriate to award prejudgment interest in this case. As stated in *General Motors v. Devex*, an award of prejudgment interest serves to make the patent owner whole, for damages properly include the foregone use of money of which the patentee was wrongly deprived. 461 U.S. at 655-56, 217 USPQ 1188. Sensonics has included in its appellate brief a reasonable methodology for calculation of prejudgment interest. Aerosonic has not challenged the rate or the arithmetic. The denial of prejudgment interest is reversed. On remand prejudgment interest, calculated in accordance with the Sensonics method, shall be awarded.

ATTORNEY FEES

The district court did not separate, in its analysis, the criteria for enhancement of damages and for the award of attorney fees. They are not necessarily the same, although the contributing factors often overlap.

[7] The award of attorney fees requires a threshold determination that this is an "exceptional case." 35 U.S.C. § 285. Bad faith and willful infringement are not the only criteria whereby a case may be deemed to be "exceptional," although when either is

present the requirement is more readily met. Litigation misconduct and unprofessional behavior are relevant to the award of attorney fees, and may suffice to make a case exceptional under § 285. *Spectra-Physics Inc. v. Coherent, Inc.*, 827 F.2d 1524, 1537, 3 USPQ2d 1737, 1746 (Fed. Cir.), *cert. denied*, 484 U.S. 954 (1987). See *Kloster Speedsteel AB v. Crucible Inc.*, 793 F.2d 1565, 1580, 230 USPQ 81, 91 (Fed. Cir. 1986) (bad faith in pretrial and trial stages, by counsel or party, may render the case exceptional under § 285).

The district court had declined to enhance damages, on the ground that the infringement was not willful. However, the district court did not discuss whether there were actions of bad faith sufficient to meet the criterion of "exceptional case" and to warrant the award of attorney fees. Sensonics points to Aerosonic's pre-litigation false statement that it was not manufacturing the device but was simply reselling it, citing Mr. Frank's letter of September 21, 1989 to Sensonics' counsel.² Sensonics states that this led it to sue Budd Electronics Corporation in the Eastern District of Pennsylvania. At trial Mr. Frank admitted that he ordered the copying and manufacture of the Sensonics device.

At his deposition Aerosonic employee Ronald Miller was testifying to similar effect when Aerosonic's attorney McDonald passed him a note stating "DID NOT COPY" (plaintiff's exhibit 52). These procedures, of which Sensonics complains forcefully, demean the litigation process.

Sensonics also points to Aerosonic's motion to the district court filed October 22, 1991, opposing Sensonics motion of October 15, 1991 to lift the stay for reexamination, Aerosonic assuring the court that the reexamination certificate had not issued, when it had issued on September 24, 1991. Before this aspect was resolved another year passed, during which the patent expired.

Combined with these actions is the matter of manufacturing records. Aerosonic employees admitted that prior serial number logs existed as late as eighteen months after the suit was filed, although no witness could tell what became of these logs. Aerosonic employees testified that they did not know how many devices were manufactured, even

for purposes of warranty control. Employees in responsible management positions testified that they did not have any records or any idea of how many devices were manufactured. The Supervisor of the Electronics Department, who personally kept the final six-months' log of serial numbers, testified that a previous log must have existed when she started the remaining log with serial number 21,267, but that it no longer existed or could be produced. As we have discussed, there is an uncompromising duty to preserve relevant records, and particularly after litigation has begun.

It is the judicial duty to refuse to condone behavior that exceeds reasonable litigation tactics. The district court made no findings concerning whether Aerosonic's actions were taken in good faith. Indeed, the court may consider the litigation actions of both sides in connection with § 285. See *Beatrice Foods*, 923 F.2d at 1580, 17 USPQ2d at 1556 (requiring findings of fact on the issue of bad faith). We remand for determination of whether there was bad faith or vexatious behavior or other grounds for deeming this case exceptional in terms of 35 U.S.C. § 285. If so, the district court may determine whether the award of attorney fees is warranted.

APPEAL OF HERBERT J. FRANK

Mr. Frank was the founder, owner, president, chief executive officer, and chief of engineering of Aerosonic. In 1990 he became chairman, his son-in-law became president, and Mr. Frank continued as chief executive officer for an additional two years. The district court found Mr. Frank personally liable for inducement to infringe the '114 patent. Mr. Frank appeals.

The tort of "inducement" under 35 U.S.C. § 271(b), when applied to invoke personal liability, is premised on a concept of tortfeasance whereby persons in authority and control may in appropriate circumstances be deemed liable for wrongdoing, when inducing direct infringement by another. See *Water Technologies Corp. v. Calco, Ltd.*, 850 F.2d 660, 7 USPQ2d 1097 (Fed. Cir.) (finding liability for inducement based on specific circumstances of personal control of Calco's manufacture of the infringing products), *cert. denied*, 488 U.S. 968 (1988); *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.*, 806 F.2d 1565, 1578-79, 1 USPQ2d 1081, 1090 (Fed. Cir. 1986) (corporate officers who actively aid and abet their corporation's infringement may be personally liable for inducing infringement).

² Mr. Frank, then president, chief executive officer, and chief of engineering at Aerosonic, wrote: "Aerosonic Corporation purchased the vibrators from another company, and if you have some legal action, it would be against them." [signed] "Herbert J. Frank, President".

[8] Mr. Frank testified that he did not have the authority to control or discontinue production of the device after he became aware of Sensonics' patent rights or as the litigation progressed. The district court did not believe this statement. We do not discern clear error in this credibility determination, for the weight of evidence was strongly contrary to this testimony. In the absence of reversible error, the district court's ruling that Mr. Frank is liable for inducement to infringe, and jointly and severally liable for the judgment, is affirmed.

Summary

The district court's rulings of validity, enforceability, and infringement of the '114 patent are affirmed. Damages shall be measured on the basis of 7,347 infringing units, without enhancement. The denial of prejudgment interest is reversed. On remand the damages award and interest shall be recalculated, and the district court shall make findings on the issue of whether this is an exceptional case for the purposes of 35 U.S.C. § 285.

On Mr. Frank's individual appeal, the district court's judgment is affirmed.

Costs to Sensonics.

AFFIRMED IN PART, MODIFIED AND REVERSED IN PART, AND REMANDED.

Patent and Trademark Office
Trademark Trial and Appeal Board

In re Broadway Chicken Inc.

Serial No. 74/326,626

Decided March 26, 1996

Released April 4, 1996

TRADEMARKS AND UNFAIR TRADE PRACTICES

1. Practice and procedure in Patent and Trademark Office — Ex parte proceedings — In general (§325.0501)

JUDICIAL PRACTICE AND PROCEDURE

Procedure — Evidence — In general (§410.3701)

Evidence offered by applicant for registration of "Broadway Chicken" mark for restaurant services, which consists of telephone and business directory listings of restaurants

using term "Broadway" in name, is sufficient to establish prima facie that significant number of third parties use trade names or service marks containing term "Broadway" for restaurant services and for goods or services related thereto, since there is no bias in directories, which were not prepared for purposes of present case but are maintained on ongoing basis for general business use, since multiple sources of third-party use evidence corroborate each other, and since Trademark Trial and Appeal Board takes more permissive stance with respect to introduction of evidence in ex parte proceeding than in inter partes proceeding.

TRADEMARKS AND UNFAIR TRADE PRACTICES

2. Infringement; conflicts between marks — Likelihood of confusion — Evidence of — In general (§335.0303.01)

Evidence of widespread third-party use, in particular field, of marks containing certain shared term is competent to suggest that purchasers have been conditioned to look to other elements of marks as means of distinguishing source of goods or services in that field.

3. Infringement; conflicts between marks — Likelihood of confusion — Particular marks — Confusion not likely (§335.0304.05)

Confusion is not likely to result from contemporaneous use of applicant's "Broadway Chicken" mark and registered marks "Broadway Pizza" and "Broadway Bar & Pizza" in connection with restaurant services, since applicant's evidence of widespread third-party use of trade names and marks containing term "Broadway" for restaurant services, closely related goods and services, and unrelated goods and services, viewed together with differences in marks and geographic significance of term "Broadway," is sufficient in ex parte proceeding to warrant finding that confusion is not likely.

Appeal from final refusal of intent-to-use application for trademark registration (Zahleh S. Khabiri, examining attorney; R. Ellsworth Williams, managing attorney).

Application of Broadway Chicken Inc., no. 74/326,626, filed October 28, 1992, for registration of mark "Broadway Chicken," for restaurant services. From final refusal of registration, applicant appeals. Reversed.

Before Rice, Hanak, and Hohein, administrative trademark judges.

APPENDIX IV

Optimization of Spin-On-Glass Process for Multilevel Metal Interconnects

Aric C. Madayag and Zhiping Zhou
Microelectronics Research Center
The Georgia Institute of Technology
Atlanta, GA 30332-0269

Abstract - Spin-on-Glass (SOG), an interlayer dielectric material applied in liquid form to fill narrow gaps in the sub-dielectric surface and thus conducive to planarization, is an alternative to silicon dioxide (SiO_2) deposited using CVD processes. The similar electrical properties between SOG and silicon dioxide guarantee that the SOG technique will provide comparable benefits to SiO_2 as an inter-metal dielectric layer. In fact, SOG has a lower dielectric constant and thus provides for better electrical insulation. However, its inability to adhere to metal and problems such as cracking prevent the easy application of SOG technology to provide an interlayer dielectric in multilevel metal interconnect circuits, particularly in university processing labs. This paper will show that a thin layer of CVD silicon dioxide and a curing temperature below the sintering temperature of the metal interconnect layer will promote adhesion, reduce gaps, and prevent cracking. Electron-scanning microscope analysis has been used to demonstrate the success of the improved technique. This optimized process has been used in three batches of double-polysilicon, double-metal CMOS wafers fabricated at the Microelectronics Research Center of Georgia Tech to date.

1. INTRODUCTION

Spin-on-Glass has many advantages. It has the ability to fill small gaps. It has been shown that SOG will fill sub-micron gaps between metal interconnects. SOG also exhibits properties similar or better than that of silicon dioxide. The dielectric constant of SOG is 3.1, where silicon dioxide has a dielectric constant of 3.9. This shows that SOG is a better intermetal dielectric insulator. The more sought after purpose of SOG is its ability to planarize a surface. Its planarizing ability makes it ideal for a premetal dielectric layer. This is because a well planarized/smooth surface is important, mechanically, for the deposition of metals.

Although a well-planarized surface is ideal for premetal deposition, chemical properties must be ideal as well. As will be shown in this paper, SOG has a property that creates a poor adhesion to metal due to its solvent nature. This can be overcome, however, by a thin dielectric layer of PECVD silicon dioxide prior to SOG deposition. Another problem with SOG is its somewhat brittle nature. When deposited over metal and cured at temperatures ranging 350 Celsius and up, the metal expands at a faster rate than the SOG. Because the SOG has almost completely solidified by this point, it can crack very easily. Also, sintering at a higher temperature than the cure temperature can decrease gaps between the metal and the dielectric layer. This is because sintering can

cause some outgassing. If the SOG is cured at a higher temperature, it is possible to cause outgassing from the metal. A Thin buffer layer of silicon dioxide was necessary. The silicon dioxide layer served as a buffer layer, chemically and mechanically, to increase adhesion to a metal layer and to buffer the expansion of metal due to increased curing temperatures. This paper will show that the combination of a thin insulating silicon dioxide layer and the optimization of solvent evaporation at lower cure temperatures can prevent unneeded expansion of a metal.

2. EXPERIMENT

This section of the paper will describe the methods of carrying out the experiment. This includes fabrication and comparison techniques. The photolithography steps are not in this paper. The comparison techniques show variations in fabrication techniques that produce the problems mentioned in the previous section.

A. Fabrication

The first metal layer was deposited in a CVC DC Sputterer. The metal layer was 6000 angstroms of aluminum. A typical line width is about 2um and spacing between interconnects for this experiment range from 2um to 10um.

The first layer of silicon dioxide was deposited by a PlasmaTherm PECVD. The thickness was 2000 angstroms. This served as the adhesive layer between metal and Spin-on-Glass.

The Spin-on-Glass used for this experiment was Honeywell 512B. It was spun on at a speed of 3000rpm in a Karl Suss RC-8 spinner with static dispense. This means that the SOG was dispensed before spinning, not while spinning, the wafer. Some care may be taken in the spin-on process. There has been research in the field of relating spin-on to tension in the SOG film.[1] The sequence of hotplate bakes was 80C, 130C, then 250C. For each temperature, the wafers received one minute of baking. The curing procedure was done at 350C with a nitrogen gas flow of approximately 17 standard liters per minute. Nitrogen flow prevented the SOG from oxidation, which can cause flakes to form.

After cure, Spin-on-Glass gives an approximate thickness of 5,200 angstroms. With a 2000 angstrom initial PECVD silicon dioxide layer, it is necessary to etch-back

2000 angstroms prior to depositing the second PECVD silicon dioxide layer.

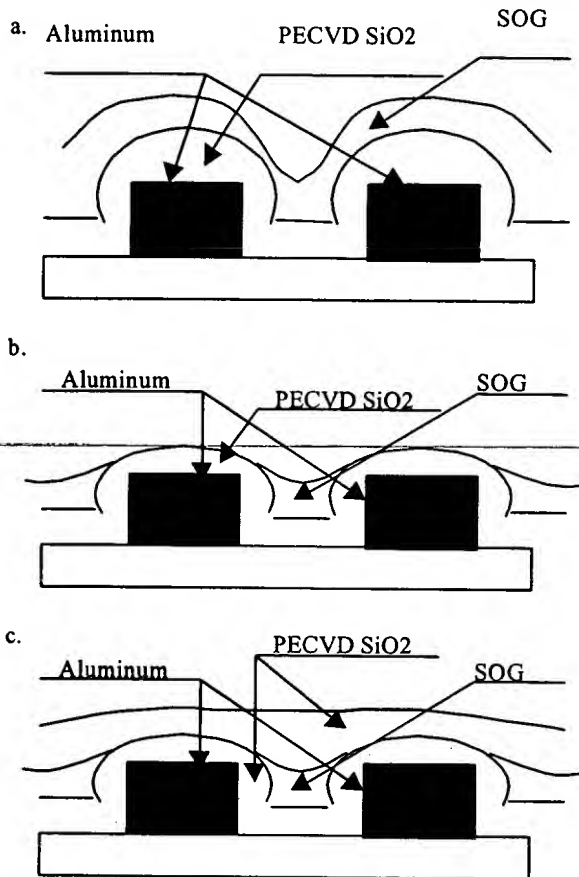


Figure 1. Three steps in SOG processing: a) SOG spin-on, b) etchback step, c) top layer of PECVD SiO2.

The next step in the fabrication process was a plasma etch-back step. This served two purposes. The first purpose was to achieve a more planar surface with the second layer of PECVD silicon dioxide. The second purpose was to make it possible to reach the desired level of dielectric thickness while being able to deposit a top layer of PECVD silicon dioxide to increase adhesion to the second metal layer. If the etchback step were not included, the total dielectric thickness would be 9000 angstroms. The goal was 7000 angstroms. This etch back process was performed in a PlasmaTherm ICP. The total etching was approximately 2000 angstroms. Because thermal silicon dioxide etches faster than SOG, the areas of higher elevation were etched away faster.

The final step to the inter-metal dielectric layer was the top part of the Spin-on-Glass sandwich. This was 2000 angstroms of PECVD silicon dioxide to achieve a thickness of 7000 angstroms of total intermetal dielectric.

B. Comparison

The two variables that were changed to prove adverse effects were presence of an initial silicon dioxide layer and the cure temperature. By removing the initial oxide layer, the metal will not adhere well to the SOG and caused peeling as well as flakiness. This also resulted in gaps forming between the dielectric and the metal. The other variable is the cure temperature. Because cures occur at significantly higher temperatures than bakes, this leaves much room for improvement. By using unnecessary high cure temperatures, a higher amount and rate of cracking of SOG occurred. Each group should find it useful to optimize the cure temperature by noting how low it can be with evaporating as much solvent as possible. Temperatures as high as 400C and as low as 200C have been shown to work with some group's requirements. The lower the temperature, the less chance of unneeded expansion of the metal beneath it. However, if the temperature is too low, there can be solvent remaining when the next PECVD silicon dioxide is deposited. One other factor noted to decrease cracking is the ramping rate.[2] A slow ramping rate will help ensure less cracking, but it is a trade off for time constraints.

3. RESULTS and DISCUSSION

Optimized Spin-on-Glass processes have produced less cracking, no gaps, and smooth features. The main features searched for are lack of cracking and gaps, and a presence of good surface smoothness. The thickness of the total intermetal dielectric, including initial PECVD oxide, SOG, and final PECVD oxide, was approximately 7000 angstroms. The SOG was cured using a temperature of 350C for one hour in nitrogen gas. Figure 4 shows a common effect of significantly higher cure temperatures. Figure 5 shows the result of lack of sufficient, if any, CVD silicon dioxide.

Figure 6 shows the scanning electron micrographs of a well-optimized SOG process. A few things to look for are cracking, gaps, conformity, and smoothness. Cracking can be seen without much inspection. With a magnification of x20k, cracking can be easily seen, as shown in figures 4 and 5. Gaps sometimes require a closer look, not necessarily by magnification, but visually. Conformity, although an important issue, is not a necessity because it is related to smoothness. If smoothness is achieved and no gaps are formed, then conformity has been achieved. The solvent nature of SOG leaves little chance that smoothness will not occur.

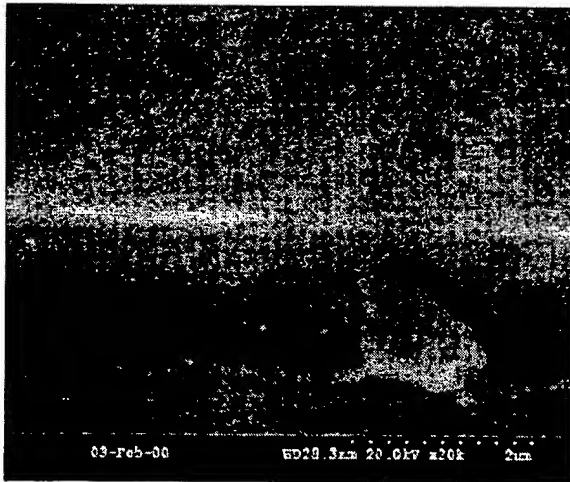


Figure 4. SEM Cross Section: Example of high cure temperature. A very large gap shown encompassing the metal.

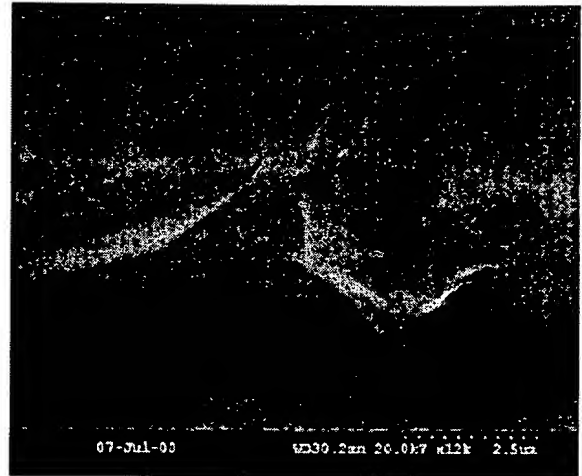


Figure 6. SEM cross section showing gapless and crackless smooth cover over metal interconnect.

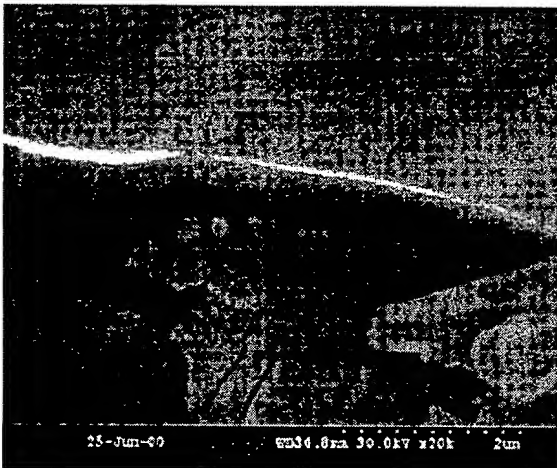


Figure 5. SEM Cross Section: Example of lack of initial PECVD Silicon Dioxide. Visible gaps and cracks are shown here.

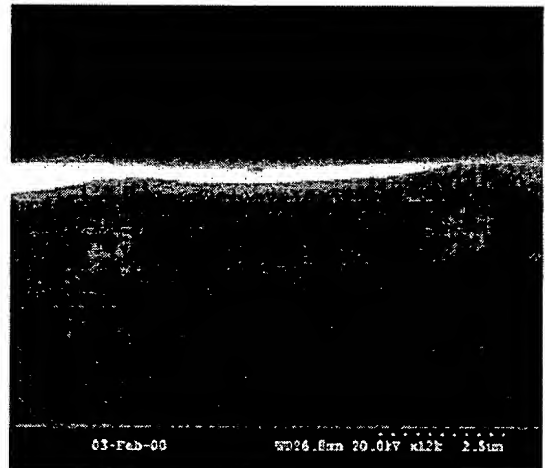


Figure 7. SEM Cross Section. Notice the small gap on the left metal interconnect.

Many methods exist to achieve extreme planarization. The two most notable are etch-back and CMP (chemical mechanical polishing). The smoothness shown in figure 6 was adequate for the needs of this experiment, however, with more than two metal interconnect layers, it is almost necessary to require complete planarization. One factor to remember is the brittle nature of Spin-on-Glass. Processing that induces a high amount of stress can cause SOG to crack as well. The best example, as mentioned in this paper, is the stress caused by metal expansion.

4. CONCLUSION

The optimization of a Spin-on-Glass process has been achieved for the Georgia Tech MiRC CMOS group. It was discovered that procedures should be optimized for requirements set by each group's process parameters. (E.g. metals, dielectric thickness, layers, etc.) SOG process parameters need to be optimized from equipment to equipment. Importance in the SOG process should be placed on initial oxide thickness, bake temperatures, and cure temperatures and ramp rate.

5. ACKNOWLEDGMENTS

The authors wish to thank the students of the MiRC CMOS group and the maintenance crew of the MiRC for their contribution and support of this project.

6. REFERENCES

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